THE

ELECTRICAL REVIEW.

VOL. LVI. APRIL 21, 1905. No. 1,430.

ELECTRICAL REVIEW.

Vol. LVI.] CONTENTS: April 21, 1905. [No. 1,430.

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THE

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THE PUBLIC AUTHORITIES' PROTECTION ACT.

THE development of municipal trading has necessarily involved local authorities in extensive litigation. In carrying out the work of electricity supply or of an electric tramway, they become exposed to actions of all kinds. Every old lady who is injured when getting in or out of a tram naturally seeks compensation for shock to the system. Are local authorities as proprietors of the tramways liable in such a case? That they are liable for the negligent acts of their servants or agents is clear to all; but it will be within the recollection of readers of the REVIEW that in 1893 an Act was passed entitled "The Public Authorities' Protection Act," which, although it does not wholly exempt local authoritities from liability in any particular case, places them in a position of considerable advantage as compared to that which is occupied by private companies.

Does this Act extend to a local authority in the performance of its duty in working tramways? This question has recently been considered by the Court of Appeal, and it may be of interest to refer to the decision.

The facts may briefly be thus stated: The plaintiff alleged that on August 9th, 1902, while travelling on an electric tramcar worked by the Southend Corporation, he was injured by the breaking of the trolley pole. He averred that he had sustained damages owing to the defective condition of the defendants' rolling-stock. He did not issue his writ until March 31st, 1903. The Southend Corporation alleged that the action was brought too late. The Act provides as follows:—

> Where after the commencement of this Act any action, prosecution, or other proceeding is commenced in the United Kingdom against any person for any act done in pursuance or execution or intended execution of any Act of Parliament, or of any public duty or authority, or in respect of any alleged neglect or default in the execution of any such Act, duty or authority, the following provisions shall have effect (*inter alia*):—(*a*) The action, prosecution or proceeding shall not lie or be instituted unless it is commenced within six months next after the act, neglect or default complained of, or, in case of a continuance of injury or damage, within six months next after the ceasing thereof.

Mr. Justice Bigham held that the Act applied, and gave judgement for the defendants. On appeal, the Court of Appeal affirmed this decision, and in affirming it they expressed opinions upon three very distinct questions in relation to the Act. (i) That the word "person," as used in the Act, should be construed as excluding bodies or persons who were traders, and in no sense public authorities. For our part, we do not see how it was material to the question under discussion to decide this point, and we should be very much interested to see the protection of the Act pleaded on some future occasion by a railway company or private company. (ii) The second point decided was that a local authority which voluntarily undertook a duty in pretended execution of an Act of Parliament could not claim pro-

tection. Upon this point, Lord Justice Vaughan-Williams said :—

In my judgement, an act which is done not only in pursuance or execution or intended execution of the Light Railway Order, but also in pursuance, execution, or intended execution, of some obligation incurred by a public authority, voluntarily beyond the obligation cast upon them by the order, is not an act done in pursuance or execution, or intended execution, of the order. I doubt whether an act done by virtue of, and in compliance with, an express contract to do such act is done in pursuance, execution, or intended execution of the order, merely because the making the contract itself only became *intra vires* by reason of the passing of the order.

He went on to say that the action of the defendant Corporation in the carriage of passengers on the light railway was something done in the execution of the Light Railway Act, 1896, as a public authority, although the Southend Corporation was under no obligation to apply for or obtain the Light Railway Order or to make or maintain the railway. (iii) Lastly, the Court decided that where the servants of a local authority are guilty of negligence which occasions injury to a passenger on the line, the authority is not guilty of a breach of contract with the passenger, but is guilty of a tort in respect of which it may claim the benefit of the Act of 1893.

With the greatest respect to the Court of Appeal, we have some doubt whether this decision will remain authoritative upon all the above points ; and if it correctly interprets the Act of Parliament, it, to our mind, discloses a state of things which should be corrected by fresh legislation. Why should a local authority, and not a private company, be a "person" within the meaning of the Act ? Why should a local authority enjoy the advantages, but be relieved to some extent of the responsibilities incident upon the working of an electric tramway ? These are questions which everyone will ask himself when he has read the above decision. That it might have been decided otherwise if the court had not been hide-bound by precedent appears from another case.

In the case of Parker *v.* the London County Council, which was heard by Mr. Justice Channell in February, 1904, a passenger on one of the Council's tramcars brought an action on January 12th, 1903, to recover damages for injuries sustained by him in an accident on June 16th, 1902. The defendant Council had acquired the tramway in question from the London Tramways Co., and was carrying on the tramway with funds provided out of the rates. The County Council pleaded that, inasmuch as the action was not commenced within six months it was not liable, and this contention was upheld. In giving judgement, however, the learned judge said that if the matter had been open to him he would have been inclined to say that on the true construction of the section the defendants would only have been protected from the consequences of negligence in the course of the construction of the tramways, not from the consequences of their servants' negligence in carrying on the work in relation to the working of the trams after the construction was completed.

Unsolved Problems in Electrical Engineering.

THIS year's "James Forrest" lecture was delivered by Colonel Crompton, who chose as his subject "Unsolved Problems in Electrical Engineering."

As the title indicates, the lecture is a brief review of the more important electrical problems which are to-day occupying the attention of investigators, with the lecturer's opinion thereon.

The subject divides itself into two parts, viz., those problems set by Nature herself, and those which have presented themselves to engineers since electrical energy began to be used in the service of man.

Under the first heading is dealt with the question of protection against atmospheric discharges, which appear to be the cause not only of much damage to bodies on or above the surface of the earth, but also of many of the mysterious perforations of the insulation of underground cables. The lecturer thinks that light might be thrown upon this problem by a more complete magnetic survey of the earth. Another problem is the etheric transmission of power, and the need of a better method of originating a continuous train of waves rather than intermittent ones for the transmission of signals.

Under the second heading are problems connected with the manufacture of electrical machinery and apparatus and their applications to commerce. One of these—the unsatisfactory nature of insulating materials, is treated at length, there being a great need of a non-hygroscopic and acid-proof insulation to take the place of the fibrous insulation used for covering wire, and not causing so great a loss of space in the winding of electrical machines. The railway problem is mentioned, and the application of single-phase motors in connection therewith.

An electrical means of producing variable torque and speed in motors is another problem which is not satisfactorily solved. Such are types of problems dealt with in Colonel Crompton's lecture.

It is difficult to place a value on a Paper like this. It is a Paper obviously written with the object of giving ideas for trained men to work upon. The lecture was addressed to an audience of technically trained men, many of whom would see the force of each idea as soon as it was expressed, but who, in all probability, would never have thought of it independently and by themselves.

A man of ideas is absolutely useless if he neither works them out himself nor communicates them to others ; but a man who will impart to others the ideas which he feels to be practicable, but which, for any reason whatever, he is unable to work out himself, is an invaluable benefactor.

Were we to attack any of the problems which are put before us, our first impulse would be to endeavour to find out what further ideas, thoughts, and speculations Colonel Crompton had upon the point.

Tests of Wind Resistance.

THAT much discussed and never solved problem of wind or air resistance at high speeds is receiving such attention at the hands of a Commission appointed by the President of the recent Louisiana Purchase Exposition, that Q.E.D. should be put to it in a short time from now. Such carefully conducted investigations on the same lines have been made, both here and on the Continent, especially on the famous Zossen experimental track, that we need not expect to hear of any startling new fact which will upset all previous calculations, but on account of the peculiar accuracy with which all measurements are being made, it may be necessary to modify in some degree existing formulæ.

The arrangement of the testing outfit is sufficiently remarkable to be sketched briefly, and we are indebted to the *Street Railway Journal* of March 25th for an interesting preliminary article in which the car and apparatus are described and illustrated.

On a pair of high-speed bogie trucks is mounted a "flat-car" frame, and supported on this is an interurban car body 32 ft. long, which rolls freely on carefully ground rails fastened to the under-frame. The wheels on which the body runs are 12 in. in diameter, and they are carried by axles which revolve in ball bearings. The body therefore is attached to the under-frame, on which all the instruments and other gear are fixed, only by means of the connections to the instruments which measure the pressure on the body. The body, in fact, is the dynamometer. Even the trolley pole is carried by the under-frame, to eliminate the effect of the friction between the trolley wheel and wire, which would have to be taken into account if it were carried by the roof in the usual way.

The closed vestibule ends are suspended independently of the body, so that the measurement of head and rear resistances can be separated from the total.

In addition to measurements of wind resistance, tests of speed, energy consumption and braking are being made ; and, as the Commission is composed of men who are well known to the world of practice, it is probable that the results sought will be such as will advance our knowledge along practical, and, therefore, commercial lines.

Peaceful Picketing.

THE Trades Unions and Trades Disputes Bill is now before the Standing Committee on Law, and is being backed by Sir Charles Dilke, Messrs. Runciman, Burns, Bell, and others. The first clause reads as follows :—

It shall be lawful for any person or persons acting either on their own behalf or on behalf of a trade union or other association of individuals, registered or unregistered, in contemplation of, or during the continuance of any trade dispute, to attend for any of the following purposes at or near a house or place where a person resides or works or carries on his business, or happens to be (1) for the purpose of peacefully obtaining or communicating information; (2) for the purpose of peacefully persuading any person to work or abstain from working.

Several amendments have been proposed, but the clause has come through scatheless. Mr. Galloway wished to limit the number of pickets to two, and thought that two or three persons should be sufficient to do all the peaceful persuading that might be necessary. His own views inclined to the old English principle that the number of pickets on each side should be equal, so that if there were 500 on one side there should be 500 on the other. The proposal was stoutly resisted by Mr. John Burns, who said it was a subtle subterfuge which struck at the very root of the principle which that Bill sought to establish.

Mr. Cripps wished to limit the conditions under which picketing should be carried out, and moved as an amendment, to insert after "acting," "in such a manner as is calculated not to lead to violence, molestation, or intimidation, or to create a nuisance or a breach of the peace, to attend."

This amendment also was very strongly resisted, Sir Charles Dilke going so far as to say that the amendment was one of a wrecking character, and Mr. John Burns expressing himself in what he called "good old Anglo-Saxon" said : "It takes the guts out of the Bill." As that remark appeared to be objected to, he defended it on the grounds that he could quote similar expressions, Marlowe, Chaucer and Shakespeare. Mr. Burns ought to know that much of the language found in the original works of the authorities quoted would not be considered Parliamentary nowadays. He gave as an alternative what he considered a very finnicking expression, "it takes the stomach and heart out of the Bill," and appealed to the Committee to defeat it, which they did by the casting vote of the chairman.

Mr. Burns claims to be voicing the rights both of unionists and free labourers, and also employers of labour, notwithstanding the fact that in one of his speeches he said that "more unreasonable pickets than those of the employers he had never come across." He strongly opposed an amendment to limit the picketing to disputes between employers and workmen on the grounds that it would damage the employers' right to resist strikers and picketers, as it would limit the opportunities of trade unions to get at an employer of labour who, not being directly involved in the dispute, might be more instrumental in resisting the demands than the man who was originally concerned. It is straining our credulity beyond its elastic limits to ask us to believe that Mr. Burns cares two straws about damaging the employers' rights to resist strikers ; what the trade unions are really aiming at is to picket works in which there is neither strike nor disagreement of any kind, in order to bring pressure upon owners of works where a dispute exists. During the last great strike very considerable feeling was evoked both on the part of the employers and employed who were non-disputants, in consequence of the trade unions' attitude towards them, and, although this amendment was defeated, we are strongly of opinion that the picketing of peaceful works is an unjustifiable interference with the liberties of the individual.

The trade unionists' idea of "peaceful picketing" is well known ; if it were not, Mr. Burns made it clear enough in objecting to Mr. Cripps's amendment. "The guts of the Bill," to use his choice Anglo-Saxon, is that peaceful picketing is synonymous with "violence, molestation, or intimidation!"

TELEPHONE FIRES.

By FRANK BROADBENT, M.I.E.E.

THE fires which have recently occurred in telephone exchanges raise the question as to whether or not sufficient precautions are taken to protect not only exchanges but consumers also against the possible danger of excess currents and pressures on the lines.

It would appear from the preliminary inquiry held by the City Coroner into the cause of the Bank Exchange fire, that the fire was due to an accidental contact between a telephone cable, which runs through a tunnel of the District Railway, and the live conductor of the Electric Railway system.

According to the report, the lead sheathing of the cable first came in contact with the live conductor, "an arc occurred, the lead sheathing was melted off the cable, and the wires came in contact with the rail. The telephone wires, used to carrying only a voltage of 22 or 24 volts, received the current at 600 volts from the rail. That current was carried to the test room of the Bank Exchange and the cable room, and caused fires at both places."

Judging from this quotation, it appears to be taken for granted that it was the contact of the telephone conductors, and not of the lead sheathing, with the live rail, which caused the fire.

How the fire actually started can probably never be known, as all trace of its origin has no doubt been effectually destroyed—burnt out. It is this characteristic feature of great fires which renders it so difficult to benefit by experience, and to take adequate preventative measures against a repetition. But consider for a moment what might happen—without special reference to the Bank Exchange fire.

The lead sheathing of a telephone cable makes contact with the live main of a 500-volt power system, which may be either the live conductor of an electric railway or the outer conductor of an electric supply authority's mains. In the one case the lead sheath is charged to a pressure of 500 volts above the earth potential, and, in the other, to a pressure of 250 volts above or below earth. In both cases there is plenty of power behind the pressure.

An arc occurs. And this means that there is a current passing along the sheath to somewhere. This current is, of course, finding its way to "earth," and back to the generating station. But it is important to know where the sheath is earthed. If in a street box or pipe, an arc may occur there, and result in an explosion. Even if the sheath is properly earthed at the exchange by means of an earth plate, the leakage current will distribute itself in parallel paths at every partial earth contact along the route, in proportion to the relative conductivities of these paths. At each point, the lead sheath may be fused, and an arc struck.

If there is no proper system of earthing, then there is a possibility—and a probability, too—of the lead sheath arcing over to the iron frame work in the exchange ; and a 500-volt arc, or even one of 250 volts with power behind it, is a very dangerous thing, and not an easy matter to deal with. A fire would result, for a certainty, if there were anything inflammable within its reach, and even if no fire occurred, it is highly probable that several subscribers would be burnt out.

The dangers resulting from contact between the telephone lines themselves, and a live power conductor, are not only from direct arcing over to each other, and to earth, but also from overheating due to excessive current.

In a modern telephone exchange, working on the central battery system, each line is provided with a safety resistance to limit the current to a definite amount in the event of its "grounding" or becoming shorted direct on to the battery ; and a fuse to break the circuit in either case. But the safety resistance is calculated for about 30 volts, the central battery voltage, and neither the resistance nor the fuse would survive a short between 500 volts and earth. It is doubtful whether any pieces would be left, even after 200 volts had tested them.

These fuses are, no doubt, excellent for their purpose ; some are enclosed in small tubes resembling a miniature

enclosed electric light or power fuse. But they would never be passed for either lighting or power circuits, as, in the event of "blowing" on a "short" they would almost certainly arc across the contacts. This, then, is the danger they are exposed to in a telephone exchange, and if one arced over with 500 volts behind it, the arc would splash across to the neighbouring lines.

Nor is the danger confined to the exchange. A consumer's lines may arc over in his telephone box and start a fire. Such fires are not unknown as a result of telephone wires falling across the trolley wires of an electric tramway. Some insurance companies now insist on a safety fuse being fitted in the lines on a subscriber's premises. But whether or not the fuses fitted are really suitable to take care of a short across a 500-volt circuit is very doubtful. It is not a question only of the fuse wire melting on the passage of an excess current, but also of breaking the arc which results from the blowing of the fuse.

The now general use of earthed electric light and power systems has introduced new conditions which did not exist in the earlier days of telephone exchanges; these new conditions may or may not be sufficiently important to necessitate modifications in telephone exchange equipment; but, at any rate, a subscriber takes a sporting risk of receiving a 500-volt shock, or of getting his place burnt down—perhaps both.

[We ought to mention that the above article was written before the further inquiry took place, of which a short account appeared on p. 615.—Eds. E.R.]

THE STARTING OF ROTARY CONVERTERS.

By SYDNEY WOODFIELD.

The method of starting rotary converters is a problem which merits every consideration on the part of the designer responsible for laying out large sub-stations. Capital cost, important though it be, should not be allowed to stand in the way of efficiency, and a little extra capital may well be expended in securing the best method of starting promptly after the complete shut-down of a sub-station. As is well known, rotary converters are perhaps more satisfactory on low frequencies, although they are built for 60 cycles with success; in this country 50-cycle machines are operating perfectly satisfactorily on the Metropolitan Electric Tramways system, and also on the Isle of Thanet system, the alternators being driven in the first case by Parsons turbines, and in the second case, by Belliss engines. In methods where synchronising is necessary, it must not be forgotten that this is more easily done with low frequencies than with high, as, obviously enough, the beating of the synchronising lamps will be about 2½ times as frequent in the case of 60-cycle machines as it would be with 25-cycle ones, and, furthermore, for the same time error in throwing in the switches, the former machine gets out of phase by an angle nearly 2½ times as large as in the case of the lower frequency machine, assuming the same speed difference in both cases. Hence it will be seen that low frequency machines can be synchronised much more expeditiously than high frequency ones.

The following methods cover all that one is likely to meet with:—

(*a*) Starting from the direct current end.
(*b*) By means of low voltage taps from the transformer.
(*c*) Compensator.
(*d*) Induction motor, *i.e.*, mechanically.
(*e*) Running up with the alternator.
(*f*) Switching direct on to line.

Under (*d*) it should be noted, one includes all mechanical methods; for instance, all the machines could be fitted with pulleys, and one run up from the other, the first machine being started by (*e*).

(*a*) This method is extremely simple, the rotary being run up as an ordinary direct current motor by means of a starting switch; the correct speed being obtained by field variation, using the ordinary field rheostat, the converter is then synchronised and put on the line. It is of course necessary to have direct current at a suitable potential available for starting the first machine, and where a battery is located in the sub-station the case is considerably simplified. If there is no battery, an induction motor-generator of a suitable size will amply repay the slight increase in cost. In a large sub-station it is obviously undesirable to supply a starting switch for each machine; a small pair of bus-bars may be run the whole length of the rotary panels, and one starter used for the whole sub-station, as shown in fig. 1.

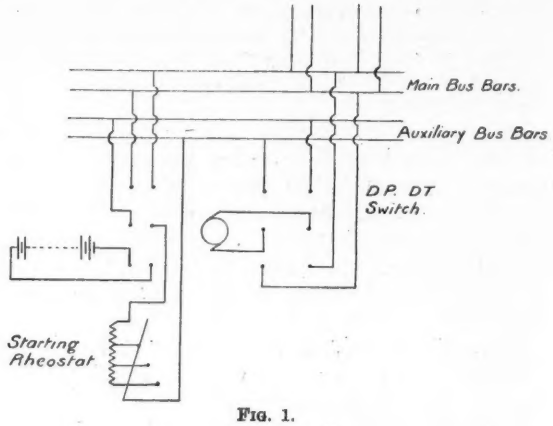


Fig. 1.

This arrangement permits of the first machine being run up and synchronised, and thrown on the direct current bus-bars, the battery being again used independently for the other machines, or, if desired, any converter can be started from the main direct current bars. In the latter case, and also if the system is arranged as in fig. 2, synchronising becomes somewhat difficult at times owing to variations in the bus-bar voltage; moreover, the former connections allow of the

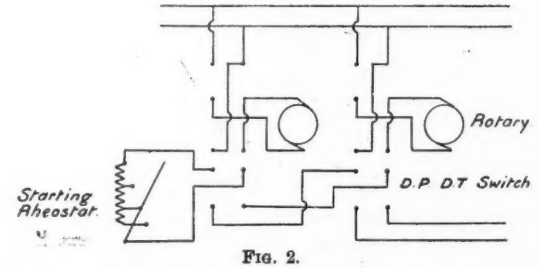


Fig. 2.

battery being charged from any particular machine by means of a regulator, without complicating to any serious extent the alternating-current board. If a battery is not located in the sub-station, the same wiring arrangement could still be used with the induction motor-generator, the generator taking the place of the battery in the diagram of connections.

In the case of both three and six-phase converters (except with six-phase diametrical or double Y connections) the slip-ring brushes should be permanently connected to the transformer secondaries, without touching the alternating board at all. This is a very important point, since, owing to the low alternating potential, the cables must be very heavy and, consequently, costly, and, furthermore, the inductance of large cables is very high. It will be seen, therefore, that no low-tension alternating switches, ammeters, &c., are required, and the low-tension cables are kept as short as possible, which tends towards increased efficiency.

Diametrical connections are now commonly used, as the higher voltage on the slip-rings (the ratio ·707 is the same as for a single-phase rotary, as against ·612 for the "delta" connections) allows of lighter low-tension cables, and only one secondary per transformer is required. With these connections, however, the converter cannot be started from the direct current end unless low-tension switches are provided, since, assuming the machine at rest, the commutator brushes may be resting on segments connected to bars which

tap on to slip-rings 180 electrical degrees apart; thus, in a two-pole machine, the two halves of the armature windings would be practically short-circuited by the secondary of one of the transformers, or shunted to such a degree as to make starting by this means commercially impossible. Although under normal conditions of working it is better to synchronise, yet under exceptional circumstances—as, for instance, after a complete shut-down, one is anxious to get the current on the line again as quickly as possible. Under these circumstances, the machine may be run up from the direct current end to a speed a little above synchronous speed, the direct current switches should then be pulled out and the machine thrown on to the alternating bus-bars without synchronising. Care should be taken, however, to pull out the armature switches before the field switch, otherwise disastrous results will ensue. This method, as a rule, will cause no trouble if the system is fairly liberally designed, or if the converter unit is small compared with the generator capacity.

From the foregoing discussion it will be seen that starting from the direct current end gives very good results; in fact, it is perhaps the simplest and least expensive.

(*b*) The second method of starting, viz, by throwing the alternating current on to the slip rings at reduced potential, this lowering of potential being obtained by means of taps from the transformer secondaries as shown in fig. 3. As is

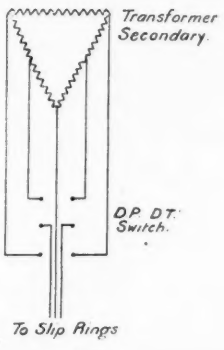


Fig. 3.

well known, the converter is self-starting from rest; when connected to the polyphase circuit it starts and runs up to synchronous speed. In converters having laminated field poles, the effect is due to hysteresis, while in the case of solid poles, foucault currents add to the starting torque by reason of their demagnetising effects. The torque is produced owing to the attraction between the alternating currents of successive phases upon the permanent field of the induced currents which are brought into existence by the preceding phase. It will be seen, therefore, that the torque is but small, and, as a rule, about three times full load current is required to start the converter from rest. Since the large starting current which lags in phase by a considerable angle would, if drawn from the line, produce a large drop of voltage in the lines, and entirely upset the regulation, besides being detrimental to the running of other plant on the circuits, taps are brought out from the secondaries of the transformers, giving one-half the normal slip-ring potential, thus allowing the machine to start up with about one and one-half times full-load current. From the diagram of connections it will be seen that a double-pole double-throw switch is required between the transformers and the slip rings, and, moreover, two extra heavy cables must be brought from the secondaries to the switch. It becomes, therefore, important to locate the transformers and switch as near together as possible in order to reduce the length of cable required. At starting, the field circuit is to the armature as the secondary of a transformer to the primary, and since the field turns are very large in number compared with the armature turns, an excessive potential would be induced, reaching, perhaps, 20 times the potential across the slip rings. In order to prevent this induced potential, the field winding may be short-circuited on itself, or what is preferable, should be sub-divided up by means of a multi-contact switch, so that, say, each pair of poles have the spools isolated and open circuited in one position, while all spools are connected in series for normal running in the other position. It must be remembered that the induced potential will be considerably higher in machines with laminated poles than it would be in the case of one with solid poles.

If the converter is compound wound, care must be taken to see that the series winding is also open. Since the E.M.F. of the brushes on the commutator is, at starting, an alternating one with the frequency of slip below synchronism, it follows that the converter may drop into synchronism at either polarity; if the polarity is wrong, the switches should be pulled out and a new trial made, or if another source of current is available, the converter may be separately excited in the reverse direction to its own excitation; this will cause it to slip a pole, and consequently give the right polarity.

This system of starting, excellent as it may appear due to no synchronising being required, possesses the drawback that extra low tension cable is required, and also a large double pole double-throw switch, and moreover, the length of low tension cable cannot be kept as short as when the slip ring brushes are connected directly to the transformers. In the larger sizes of machines which are now designed for six-phase operation (owing to the large increase in capacity, a three-phase machine has an output of 34 per cent., and a six-phase 96 per cent. greater than an equivalent direct-current generator, the copper losses being the same in each case), it becomes practically impossible to use this system of starting, and if no direct current is available the induction motor method must be employed. From the foregoing it will be seen that this way of starting is, as a whole, good, as no synchronising is required, but other considerations make it somewhat expensive, and moreover, the fact that one can never tell which polarity the converter may take, gives it an element of uncertainty, although by means of a voltmeter an experienced attendant can generally manage to throw in the field switch at the right moment.

(*c*) The compensator method of starting acts to all intents the same as the previous method, viz., by reducing the impressed E.M.F. on the converter slip rings. The mode of reducing the voltage, however, is different, a compensator being used, this piece of apparatus being usually located as shown in fig. 4, between the high tension lines and the trans-

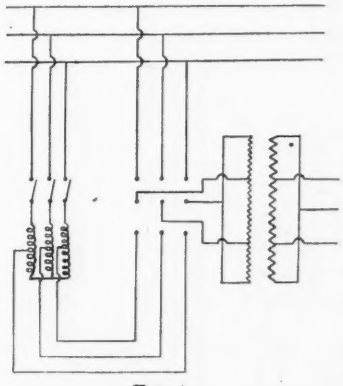


Fig. 4.

former primary. The double-throw switch having to handle a small current, can with the compensator be located in the most convenient position, while the large low-tension alternating cables can be kept as short as possible, as no low-tension alternating switches are required. Generally, a couple of compensators may be used in a sub-station, arranged in such wise that either can be used for starting any machine.

From the foregoing it will be noticed that this method possesses all the good features of the previous way of starting, more especially in not having to synchronise, and at the same time gets rid of some of the defects in the previous method, viz., the large low-tension switch, &c.

A method but rarely used is shown in fig. 5. As is well known, the ratio of the alternating to the continuous potentials of a converter is practically constant, and in order to vary the continuous potential, the applied alternating potential must be varied, a certain amount of reactance is

therefore put in the alternating lines as shown in the diagram, and by varying the converter field the current is made to lead or lag, thus giving a rise or a drop of potential.

The reactance is wound with two coils per core, at starting the two windings per leg are put in series by means of the double-throw switch, while for running the second winding is cut out, the transformers being connected through the single reactive coil to the slip rings.

(*d*) This method is largely used and is a purely mechanical one. A small induction motor is usually supplied with its rotor keyed on to an extension of the rotary shaft, the stator frame being bolted to the bearing pedestal. The stator is wound with a smaller number of poles than the rotary, so that it runs at a somewhat higher speed. After the motor has been switched on to the line and run up to speed, the

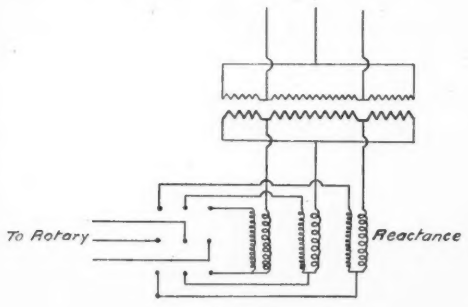


Fig. 5.

rotary field switch is closed and the converter excites itself, the speed of the set is then reduced to the synchronous speed by loading one phase of the rotary by means of a special rheostat supplied for the purpose. The induction motor varies in size with the capacity of the converter, but is usually 6 per cent. to 10 per cent. of the full load output. This method only takes a small current from the line, and is therefore not likely to upset the regulation; moreover, only small cables are required between the slip rings and the transformers or the live side of the low tension alternating main switches. This is a point of considerable importance, as in large sizes of machines in some lay-outs, the cost of cables more than balances the cost of the induction motor. This method, however, labours under the disadvantage that one cannot connect the slip-rings direct to the transformers unless a special starting transformer is used. There is no reason, however, why this should not be done, as the cost would be very slight and the advantages considerable.

Taken as a whole, this method is one of the simplest and least difficult to operate, and a smart man can have the set run up and synchronised in a very short time.

(*e*) This method of running up the machine with the alternator is an ideal way, as it obviously is the one giving least strain to the plant; but, unfortunately, it is commercially impracticable except in the case of the first converter to be run up.

The mode of operation is to leave the high tension switches to the transformer primaries as well as the secondary closed, so that the converter is always in synchronism with the alternator from the start. Just as soon as full speed is reached, the field switch may be closed, and if of the right polarity, the machine can be put on the direct current bus-bars.

(*f*) As a rule, only small machines can be thrown directly on the alternating bus-bars, for, as already explained, the disturbing effect on the system with a large machine would be prohibitive; it is therefore unnecessary to discuss this method further.

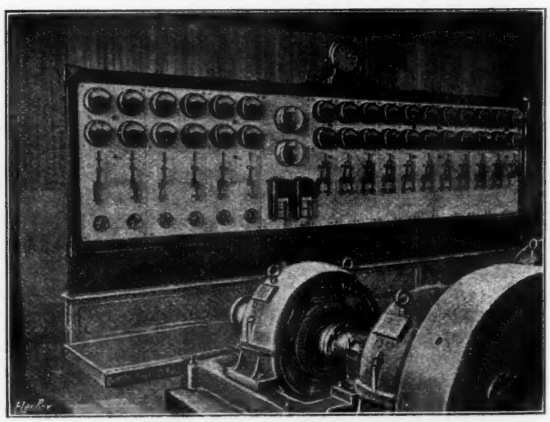
From what has been said, it will at once be evident that, starting from the direct current end is preferable in all cases where it can be arranged for, and, failing this, especially with large six-phase machines of high frequency, the induction motor method is practically the only one available. However, each particular scheme is somewhat controlled by local conditions, and therefore no hard and fast rule should be adhered to.

ELECTRIC LIGHTING OF THE MIDDLEBURG CANTONMENTS, SOUTH AFRICA.

[From our Durban Correspondent.]

The electric light installation at the Military Cantonments at Middleburg, Transvaal, has lately been put into operation, and as this camp is the first in South Africa to be equipped throughout with electric light, a short description of the plant will, no doubt, be of interest.

The generating station is situated at about the centre of the camp, and comprises boiler room, engine room, store room and small workshop. The steam plant consists of three Ruston-Proctor locomotive type boilers, each capable of evaporating 3,300 lb. of water, and working at a pressure of 150 lb. per sq. in. In order to obtain this evaporative capacity with the inferior quality of coal obtainable in the country, the boilers are fitted with fire-boxes of large dimensions, and the stack on each boiler is 60 ft. high. Two feed-pumps of Pearn's compound duplex type are installed, each capable of dealing with the water required for the three boilers; and duplicate feed-water pipes are provided and arranged for pumping the water either through an exhaust steam feed-water heater, or direct to the boilers.



Middleburg Cantonments: Main Switchboard.

The boilers are connected by a 6-in. steam main, from which connections are made to the pumps and three engines, so arranged that any boiler may be employed to feed any engine.

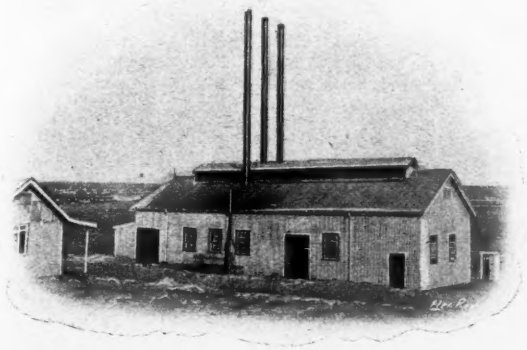
In the engine room are installed three direct coupled steam generating sets, each comprising a Willans two-crank compound 100-I.H.P. engine coupled to two Electric Construction Co.'s compound-wound multipolar generators, each capable of giving 25 KW. at 250 volts, the dynamos being arranged in tandem at one end of the engine shaft and connected to supply current to a three-wire system. The sets are designed to carry an overload of 25 per cent. for three hours, and the field windings arranged to give a 5 per cent. rise in pressure between no load and full load. The maximum load on the station can be carried on two sets, and at 10 p.m., when the men's lights are switched off, one set carries the load.

The switchboard, which was built by Messrs. Nalder Bros. and Thompson, is arranged for a three-wire system; it consists of 15 white marble panels, mounted on an iron framing and surrounded with wood moulding. The general arrangement is shown in the accompanying photograph. Each of the three generating panels carries two ammeters, two voltmeters, two S.P. main switches and fuses and shunt field rheostat. The recording instrument panel contains two Chamberlain and Hookham 250-volt wattmeters and two Elliott Bros.' 250-volt recording voltmeters. The feeder panels, 11 in number, are each provided with two ammeters, a D.P. main switch and two fuses. An "earth" panel is also installed, carrying a recording ammeter with automatic cut-out and resistance, through which the neutral bar of the three-wire system is earthed.

One of Messrs. Herbert Morris & Bastert's 2-ton overhead travelling cranes for a span of 30 ft. has been erected in the engine room.

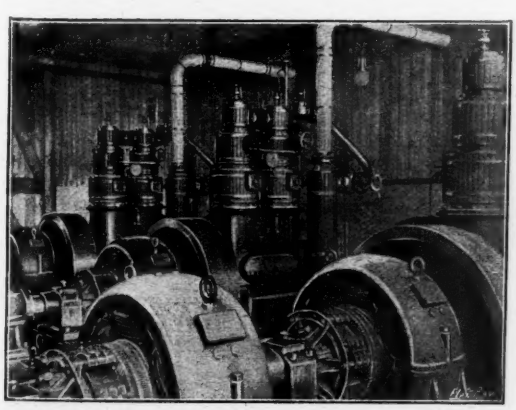
All the main feeders and distribution network are laid underground; some 30 miles of cables have been installed, all of the British Insulated and Helsby Co.'s paper-insulated lead-covered and steel tape armoured type. The main feeders are run to 11 different points in the camp, so that each set of lines, serving the hospital, the officers' houses, the married soldiers' quarters, &c., are separately controlled from the engine room switchboard.

The main feeder cables terminate in either a guard room or in a distribution pillar, in which are fitted two double-pole distribution fuse boxes whence twin mains are run to the various buildings. The sizes of cables have been calculated to give a maximum drop in pressure of 5 per cent. to the furthest lamp at full load.



Middleburg Cantonments: Generating Station.

Within the barrack lines, where the buildings are numerous and each contains only from 1 to 10 lights, the circuits from the distribution centres are so arranged that the current on any circuit does not exceed 5 amperes, and no fuses other than those in the main distribution box are employed. The cables are looped from building to building, and the ends sealed with cast-iron boxes in which are provided disconnecting terminals, so that any section of cable can be readily isolated for testing purposes. The larger building, such as officers' houses, &c., are each fed by separate twin cables from the distribution pillars, and the internal wiring is carried out on the usual distribution system. These buildings are fitted with bells throughout, and each cell in the prison is also fitted with a push for ringing a bell in the guard passage.



View of Generating Plant.

For the hospital wards special revolving fittings are provided, so that the lights can be turned upwards, and the rooms lighted by the reflected light from the ceilings only.

The main distribution boards are fitted on one circuit only with D.P. switches, which control the street lamps. These are 55 in number, and are Nernst type of 1-ampere, erected on lamp pillars with cast-iron bases, in which are fitted boxes similar to those in the buildings.

The lighting of the buildings, numbering nearly 400, is carried out with incandescent lamps, of which upwards of 3,000 have been installed. All buildings (with the exception of officers' houses and messes, where casing has been used) are wired in screwed heavy gauge steel tube, which is effectively earthed to the lead sheathing of the underground cables, by being screwed into the cast-iron boxes referred to above.

The accompanying photographs show views of the generating station. The work was carried out to the plans and specifications of Mr. M. Astley Shute, the electrical adviser to the military authorities, South Africa, and Messrs. Hubert Davies & Spain, of Johannesburg, Pretoria, and Durban, were the contractors for the whole installation, including plant, underground cables, and internal wiring and fittings of the buildings.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Light" writes:—"I purchase from the makers through a Berlin agent goods manufactured there and sell them in England. The goods are patented in England, and the makers have an English house in London. By buying in Germany I save 30 per cent. (1) Do I in any way act illegally? (2) Can the Berlin or English houses take action against me for so importing and selling the goods in England?"

*** If (as we apprehend) the goods in question are the subject matter of English letters patent, it is quite clear that the patentees have a monopoly of their manufacture or sale in England. This being the case, it is obvious that the patentees are entitled to the 30 per cent. which "Light" saves by purchasing in Berlin. In the circumstances the answer to the queries should be in the affirmative.

LEGAL.

Patent Exploitation, Ltd., *v.* American Electrical Novelty, &c., Co., Ltd.

This case came before the Court of Appeal, composed of Lords Justices Vaughan-Williams, Romer, and Stirling, on Tuesday last week, on the plaintiffs' appeal from a judgement of Mr. Justice Buckley in the Chancery Division.

Mr. A. B. Shaw, in opening the case, said it was the plaintiffs' appeal from a judgement of Mr. Justice Buckley in a patent action in relation to galvanic batteries. The learned Judge found on both points in the case against the appellants, the two points being infringement and validity. The case was tried in the summer of 1903. Shortly before this, another action by the same plaintiffs against other defendants had been tried, and on appeal to that Court Mr. Justice Buckley's decision against the plaintiffs was reversed, and it was held that the patent was valid. Thereupon, the present action was started, and it came on before Mr. Justice Buckley, when the defendants' appeal in the other case from the judgement of that Court to the House of Lords was pending. It was felt that a good deal would depend on what happened in the House of Lords. About a year after the judgement of Mr. Justice Buckley the House of Lords gave their judgement, affirming the decision of the Court of Appeal, and holding the patent valid from a certain construction of it. The present appeal had stood over to await the event of the appeal to the House of Lords. He (counsel) understood that validity was not contested now. They would simply have to fight the question of infringement. Mr. Shaw, continuing, said that the patent sued upon was No. 1,110 of 1890, granted to one Hitchcock. It was a communication from abroad of a patent for a dry cell. At the trial a great deal of evidence was given as to the state of the art at the date of the letters patent. The plaintiff made one pole in the form of a zinc cup, so that it acted as an outside casing as well as a pole electrically. He had then his carbon central rod, which was the other pole, and he had nothing between these two except two layers, both being exciting layers, and the inner one must be a depolarising layer. The Appeal Court and House of Lords had said that that was new as a combination, and that nobody before had made an effective dry battery which had this and nothing else. The patentee used a semi-solid or plastic exciting agent, and plaintiff's evidence showed that if

enough fine stuff was used, it would hold up the water by capillary attraction.

Lord Justice Romer: Does the defendant say he has not got a semi-solid or plastic exciting agent?

Mr. Shaw: Yes; he has a damp solid. He has not got enough water there to make it semi-solid or plastic, and he also says he rams harder, and that that is too far away from packing to be plaintiff's invention.

The hearing was adjourned, and resumed on Wednesday.

Mr. Shaw, continuing his opening statement, said the Judge below had held that plasticity was of no value, but he could not accept that finding. The patentee had given a prescription which produced a substance which he called semi-solid and plastic. It must be sufficiently nearly solid to stand up as a layer, and it must also be plastic in order to make good contact with the other layer and with the electrodes. No one had previously made a commercially successful battery with these elements and no other.

Mr. Walter then proceeded to open the respondents' case. He said he did not propose to contest in that Court the issue of validity, but his clients said that on the true construction of the patent they did not infringe. The thing described in the specification was something that set. That meant that the condition of the outer layer was not hard, but semi-solid. He contended that the plaintiffs' patent did not cover the use of a liquid battery, a battery in which the liquid was merely absorbed by absorbent material, and that an outer layer composed of merely absorbing materials which took away the character of spillability, was not within the plaintiffs' patent. That was common ground. The use of *papier maché* and blotting paper in a battery was old.

At the sitting of the Court on the 20th inst., Lord Justice Vaughan-Williams stated that he and his learned brothers did not wish to hear Mr. Walter on the question of infringement further. As there was no question of validity raised, it was only necessary for him to state that as at present advised the Court was of opinion that the blotting paper arrangement used by the defendants was not an infringment of the plaintiffs' specification.

Mr. Shaw having briefly replied,

Lord Justice Vaughan-Williams, in giving judgement, said the only question they had to decide in this case was whether the patentee had proved that the defendants had infringed upon his combination as described in the specification. His Lordship, having read the material passages in plaintiffs' specification, said the defendants had substituted blotting paper, and the suggestion was that this blotting paper sufficiently came within the description of "being a composition in a semi-solid or plastic state," and it was said that although, of course, the difference was manifest upon the mere statement of it, the difference ought not to be regarded as preventing an infringement because of the power of variation. It was said that the power of variation allowed of this substitution of blotting paper. His Lordship did not think that the judgements in the House of Lords would authorise this Court holding that this variation of the plaintiffs' patent—the introduction of blotting paper was a variation of a character which was covered by the words in the specification in paragraphs 15, 23 and 31. Even assuming that blotting paper came within the definition of the word "plastic," yet he thought that the variation was not such as was covered by the words in the specification, because even if blotting paper came within the category of materials as mentioned in the clause, yet one must look at the whole of the specification, and if one looked back to the earlier part of the specification, it was plain that you could not so deal with the blotting paper. A suggestion was made that you could tear up blotting paper, and pour it in with some water. He did not think that would be sufficient to bring it within the description in the specification. In his judgement blotting paper could not possibly come within that description, nor was it in any way analogous or similar to the materials and composition used by the plaintiffs. In his opinion, therefore, the appeal must be dismissed with costs.

The other Lord Justices concurred.

PARLIAMENTARY.

Croydon Corporation Bill.

Mr. Bill's Select Committee of the House of Commons on Tuesday and Wednesday last week considered the Croydon Corporation Bill, which, amongst other things, contained clauses to authorise the construction of about 7 miles of tramways and the running of motor-omnibuses.

Mr Gerald Fitzgerald, who appeared for the promoters, said the proposal of the Bill was to construct certain new tramways, and to inaugurate a system of motor-'buses to outlying districts about a mile beyond the borough boundary. To these proposals the Penge U.D.C., the Croydon Rural District Council, the British Electric Traction Co., and the South Metropolitan Tramways Co. were appearing in opposition. The position of affairs was that the B.E.T. Co. were the lessees of the Croydon tramways, which lease could be determined in 12 months' time. So far as the other company was concerned, they had merely taken over a very short length of line from the B.E.T. Co. outside Croydon, and therefore their interests were very slight. There would be no competition between the tramways and the 'buses, and he could not see why there should be opposition to the Bill. As a matter of fact, anyone could secure a licence for running over the omnibus routes which the Corporation proposed, and the companies would have no right to object.

Mr. Lloyd, the Town Clerk of Croydon, was called in support of the Bill.

In cross-examination by Mr. Ram (for the Penge U.D.C.), he said he did not think the powers in the Bill to make agreements with outside tramway authorities would prejudice the rights of Penge with regard to their tramways.

By Mr. Vesey Knox (representing the Croydon Rural District Council): He admitted that no communication had been made to the Rural District Council as to the proposed routes. In fact, the Corporation had not considered any specific routes until that morning.

In reply to Mr. Moon, K.C., who appeared for the two opposing companies, witness again denied that there would be any competition with the tramways. They relied on several precedents for these motor-'bus powers, and especially the case of Eastbourne, where the Corporation had power to run buses outside their district.

Mr. George Carter, borough engineer, described the proposed omnibus routes, which were 14 in number. He considered they were all the available bus routes beyond the borough.

In cross-examination by Mr. Moon, Witness admitted that upon some of the proposed omnibus routes tramways had been authorised but had not yet been constructed. It was principally owing to the delay of the tramway company in constructing the lines that this omnibus service was thought of. They would meet a public want, as they would go by recreation grounds just beyond the borough boundaries to which at present there were no means of communication. The Corporation was willing to withdraw the routes over which the tramways were authorised and not built, if the Tramway Co. would give an undertaking to construct the tramways within a reasonable time.

By Mr. Ram: It was proposed by the Bill to borrow £12,000 to purchase 12 omnibuses at first.

Without calling upon the opposition, the Chairman said the Committee was in a position to give their decision. It was only in the case of a thoroughly well-considered and thought-out scheme that such powers could be given, and as in this case it seemed that the scheme had not been well considered they must strike out the clause.

Mr. Fitzgerald said that in consequence of this decision the power to enter into agreements with outside authorities would be withdrawn.

After some discussion, the clause giving the Corporation power to supply electrical energy in adjoining districts was agreed to.

There was no opposition to the tramway proposals.

The Committee fixed the period of repayment of the tramway loan of £67,174 at 30 years.

Heckmondwike U.D.C. Bill.

On Wednesday, Mr. J. W. Wilson's Select Committee of the House of Commons concluded their consideration of the Heckmondwike Improvement Bill, which, amongst other things, gave further powers to the U.D.C. in respect of their electricity undertaking.

Mr. Wedderburn, K.C., who, with Mr. Hutchinson, was for the promoters, said that in accordance with the decision of the Standing Orders Committee, Clauses 10, 11, 12 and 13 were withdrawn. The object of these clauses was to confirm an agreement with the British Electric Traction Co.; to supply electricity within portions of Liversedge and Batley; and the supply of electrical energy for traction purposes.

Clause 14 was opposed by the Yorkshire Electric Power Co. The clause was:—"The Council and any local authority or person for the time being authorised to supply electrical energy may, with the approval of the Board of Trade, and subject to the provisions of the respective Acts and powers under which such local authority or company are or may be empowered to supply electrical energy, enter into and carry into effect agreements for the supply of electrical energy in bulk by such local authority or company to the Council."

Mr. Baker (Parliamentary agent) said that to meet the objection of the Yorkshire Electric Power Co., they had agreed to make the clause read as follows:—"The Council and any local authority or person for the time being authorised by Parliament or the Board of Trade to supply electrical energy without their own areas may, subject to the provisions," &c.

The clause, as amended, was agreed to.

The Committee agreed to Clause 15, which gave power to supply electric fittings, but struck out Clause 16, provided that the provisions of the Electric Lighting Act of 1882 should extend to enable the Council to make bye-laws with respect to any wires, apparatus, or fittings in any buildings or premises supplied by the Council with electric energy.

Clause 17, which had reference to the supply to consumers with a separate supply, and Clause 18 requiring notice from consumers terminating their supply were passed.

Mr. Hutchinson submitted Clause 19 as follows:—"The Council may for the purpose of lighting public lamps, or on the application of an owner or occupier of any premises within the electricity limits of the Council abutting on or being erected in any street not repairable by the inhabitants at large, for the supply of electricity to such premises, lay down, take up, alter, relay or renew any pipe or apparatus as may be requisite for such purpose or for the furnishing of such supply."

Mr. Baker said the Urban District Council was supplying light and power, and also the British Electric Traction Co. for the purpose of running their cars through the town. Under Clause 13 of the Electric Lighting Act of 1882, it was provided that the undertakers should not break up any street not repairable by the local authority without the consent of the persons by whom such street was repair-

able, but the Board of Trade had power to dispense with the consent of any person who might object. The result of this was that a very considerable amount of delay was occasioned, and the Heckmondwike U.D.C. had had experience of such delay.

Mr. Macaulay, the Clerk to the Council, gave evidence as to a street not 100 yds. long, where considerable delay was occasioned in waiting for the dispensation of the Board of Trade.

In answer to the Chairman, Witness said of course the work was done eventually.

The Chairman: How have you varied the form?

Mr. Baker said merely by extending it to electric mains. The model Bill allowed it in every case with regard to gas and water mains, and the Bill just introduced into Parliament under the title of the "Supply of Electricity" Bill by the Board of Trade also contained the section.

A Member of the Committee: Can't you wait until that Bill becomes law?

Mr. Hutchinson: It might not become law.

The Member: Then it would not be a good law for you to have?

The Chairman: As I understand it, this is a power which is desired by Heckmondwike, and is not required by any other town.

Mr. Baker said it was in the Carlisle Bill of last year.

The Chairman: You said it was the model clause.

Mr. Hutchinson said it was a power given to gas undertakers, and was exceedingly useful. Why discriminate between gas undertakers and electric lighting undertakers?

The Chairman said the clause in the Carlisle Bill was only for private lighting.

After deliberation, the Chairman said the Committee were not impressed with the necessity for this clause simply as a short cut to avoid a little delay, and they did not feel inclined to make an exception in the Heckmondwike case. Clause 19 was accordingly struck out.

Great Northern, Piccadilly and Brompton Railway Bill.

Mr. Crompton Rickett's Committee which considered the above Bill has presented a report to the House. The proposal to abandon certain portions of the sanctioned lines, and the release of deposit money in respect thereof, were allowed. Payment of 3 per cent. interest out of capital during the construction of the railways is to be permitted. The Bill sought powers for making a railway from the authorised termination of the company's railway in the new street north of the Strand to Waterloo Station. It appeared from the plans and sections that the proposal was to construct the proposed railway No. 2 (which would pass under the River Thames) as a single tunnel only, but having regard to the extent of the traffic which from the evidence given to the Committee seemed likely to traverse the proposed line, the Committee had inserted a clause in the Bill providing that the proposed railway No. 2 shall not be opened for traffic unless and until an additional tunnel has been constructed, so as to provide separate tunnels for up and down traffic.

In the House of Lords last Friday the following Bills were read a second time:—Chelsea Electricity Supply, Weybridge and Walton-upon-Thames Electric Supply.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

"Electricity in Mines" Regulations.

As a consulting engineer connected with the installation of electricity for power and lighting purposes in coal mines, I have been much interested in your remarks in to-day's issue of the Review on the new Home Office Rules, and note that you consider that they have been carefully and admirably drawn up.

It would, however, be interesting to know what steps colliery managers are proposing to take to comply with Clause 37, Section V., which says that all motors and their accessories, except under certain conditions, are to be enclosed in flame-tight enclosures "of sufficient strength as not to be liable to be damaged should an explosion of fire damp occur *in the interior*."

Is there anything on the market at present that will comply with this condition?

Q.

A.C. v. D.C.

Once upon a time the shift engineers at Tunbridge Wells, in spite of the enormous superiority of the A.C. man, could only command a "salary" of £50 or £52 a year. I don't think any D.C. shift engineers ever worked for less. Switchboard men at Worcester, during the intervals not filled by Nap (both kinds) and fishing, used sometimes to synchronise alternators, invariably escaping with their lives. These men—I speak from experience—although in receipt of an income amounting to 15s. a week, were a thoroughly discontented lot. Isn't it strange that even at the present time D.C. shift engineers average the larger salaries? I expect this is because the A.C. man is spending his time proclaiming what a superior being he is, and instead of attending to his work—*i.e.*, asking for rises—is flapping his wings and crowing on top of a hill which will soon be wanted for agricultural purposes. I think most shift engineers could manage *any* station, whether A.C. or D.C., after two weeks, at least let us hope so; but the A.C. man would feel very strange in a D.C. station, and *vice versa*. Trusting Mr. Boot will give W. Talboys Wheeler, Esq., some more work to keep him from being childish.

A. J. Abraham,
Electrical Engineer, Lanark County Council.
Cambuslang, *April 14th*, 1905.

Patent Agreements.

Your article of March 24th, on patent agreements between companies and their engineers, touches on a subject which has borne very heavily upon me for at least 20 years.

I have had the privilege, or the misfortune, to view this question from both sides; I have seen it from the side of the director, and I have seen it from the side of the inventor.

In the days of our dear old friend, General Webber, the Anglo-American Brush Co. imposed upon their engineers an agreement which was not unlike the more drastic of the two agreements you have described, in that it treated the inventor as the whale did Jonah. The result of that agreement was paralysis.

In later years I persuaded the board of the reconstructed Brush Co. to modify the agreement, but even in the improved form its effect was still paralytic. I have also taken a hand in framing agreements similar to the other and milder agreement which you describe. These have led to better results, though of a very feeble character.

Boards of directors do not find any difficulty in grasping the primary idea that the efforts of their financial managers should be stimulated by a participation in profits, but I have never met with a case in which directors have appreciated the services of their engineers at anything beyond a nominal salary, though they carried the foundation of the business on their shoulders. This is the reason why so many of my friends who were originally servants of companies are now earning independently a thousand for every hundred of their former salary. The sum total of my 20 years' experience is that the agreement has yet to be drawn which will be better than no agreement at all.

Any agreement that tends to discourage invention is bad. The life of a mechanical or electrical inventor at best is not usually a happy one, and unless he be in a position to do his own financing in the earlier stages, he may have to part with 90 per cent. of his interest before he can see the wheels go round.

Every manufacturer looks upon the inventor as an invader unless the invention can be secured for nothing, or its equivalent. There is, therefore, no incentive to invention in this country except a certain vague sentiment that Providence will reward the inventor—which It does not.

Happily, for this country, the above sentiment is ineradicable, and men go on thinking and working to produce better results under the delusion that what they do for the public will reflect on them to their own advantage.

I say this because I have seen it. In my own case, the exercise of the few wits which I owe to my mother has afforded me so much interest and pleasure in life that I have not considered the question of profit. This, of course, is a purely personal aspect of the question; the business aspect of the question from the electrical engineers' standard is, that in any modern manufacturing establishment the inventor is a necessity, progress is imperative, as Mr. George Westinghouse said, "standardisation is stagnation." We must go forward at full power or the tide will carry us back, consequently, we want every possible stimulant to invention. Any agreement which tends or might tend to diminish the incentive towards improvement provided by statute is a sin against the State, and should be made illegal.

There is only one case in my mind in which a restrictive patent agreement is admissible; that is when an engineer or draughtsman is taken on to work out an invention. In such a case he is paid to apply his mind to the problem (a definite problem), and I think his employer ought to have the full benefit of his suggestions.

At the present moment I am actually in this position as an employer, but I do not consider my mental capacity equal to framing an agreement which will be better than no agreement, so I leave it just where it is.

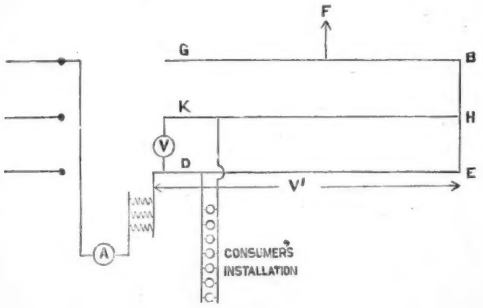
The jury in this case consists of your readers (more than 12). I ask them to say on the evidence adduced, that patent agreements are useless—that they injure companies that impose them, without any corresponding advantage to the state of the inventor.

John Raworth.

Westminster, *April 11th*, 1905.

Localisation of Faults in Cables.

Acting on Mr. Bergh's valued suggestion, we promptly obtained copies of the *Electrical Magazine* for October and November, and have read with much interest the articles he mentions. In these articles it is stated that the tests can be applied without access to consumers' premises, and in Mr. Bergh's letter he also says that it is quite unnecessary to



open the consumers' main switches; but we quite fail to understand how the test can be applied if, as is most probable, a consumer's installation be in circuit as a shunt across the voltmeter. For example, fig. 1 shows the connections for Mr. Bergh's first test. Will not the consumer's installation materially alter the reading of the voltmeter? Perhaps Mr. Bergh will kindly explain.

Weary Willie and Tired Tim.

The comments of "B. S. H." on my previous letter are very disappointing, as they show that the writer has had very little practical experience of the subject.

Of course, one can quite understand how any suggestions for saving time are valueless to a mains engineer who writes about finding a fault of thousands of ohms resistance.

I still most emphatically maintain that the removal of consumers' main fuses, the use of secondary cells, and the running of testing leads are all absolutely unnecessary in locating faults on electric light mains. One can offer advice, but, unfortunately, one cannot supply practical experience.

In conclusion, I would apologise to "B. S. H." for having failed to enlighten him, but trust that some of your readers will grasp the value of my suggestions and benefit by them.

F. C. N. Bergh.

[We have omitted some irrelevant passages from Mr. Bergh's letter.—Eds. E.R.]

Street Openings.—According to the *Times*, a conference of road authorities is to be held at Westminster City Hall, on May 19th, to consider the opening of the streets by the Postmaster-General and public companies. The main question to be considered is the protection of traders and the public.

A NEW GERMAN ELECTRICAL FUSION.

Another addition to the list of amalgamations in the German electrical industry, which has already witnessed the consolidation of the Siemens and Schuckert works on the one hand with a share capital of £4,500,000, and of the Allgemeine and Union Electricity Companies on the other with a similar amount of capital, is proposed to be made by a fusion of the Felten and Guilleaume Co., of Mulheim, and the Lahmeyer Electricity Co., of Frankfort-on-Maine. An official announcement on the subject states that, subject to the consent of the shareholders at forthcoming meetings, the directors of both companies have entered into an arrangement for the transfer to the Mulheim Co. of the manufacturing departments of the Frankfort Co. The Lahmeyer Co. will thus be left to continue the financial side of its business in relation to various electrical undertakings in which it is interested, while the capital of the Felten & Guilleaume Co. will be increased from £1,800,000 to £2,750,000 for the purpose of absorbing the former's dynamo and other manufacturing departments, and also for strengthening the working capital. The fresh capital will be issued at a premium, and the title of the new concern will be the United Felten & Guilleaume-Lahmeyer Works Co.

PRICE LISTS.

By TOM HOOD.

The important question of providing price lists, pamphlets, extracts, &c., of their goods is one on which a vast amount of money is spent by merchants, and it has always been questionable to the writer whether the time and money so spent are used to the best advantage.

It has become a thoroughly established fact that price lists are indispensable as an aid to business, but there seems to be such an utter want of standardisation in their preparation that a very large proportion of the money spent is absolutely wasted.

To take our own trade or profession, I have frequently noticed, whilst travelling about the country, the uses to which lists are put, and if they are not consigned to the W.P.B. or the grate, they are flung on to a huge pile of other lists which might just as well be destroyed for all the use that is made of them.

The amount of money spent annually on trade literature must be enormous, and it is probable, at a moderate estimate, that not less than £25,000 is spent in the electrical trade alone, and if one-half of the total number of lists published is productive, then it means that there is a loss of £12,500 per annum which, if devoted to advance the interests of the trade in other directions, would prove most serviceable.

It would therefore seem to be not only highly desirable, but also an inestimable boon to both the manufacturer and the contractor if means could be found whereby this great waste could be prevented, and, in order to do this, it is necessary to locate the primary causes which lead to such losses.

Two of the principal causes of this waste are undoubtedly as follows:—

1. Want of standardisation by manufacturers.
2. Want of appreciation by the trade of the value of the lists they receive.

To analyse No. 1, it can safely be said that there are few callings in which lists present such a variety of colours, sizes, shapes, gross prices, discounts, &c.

In order that a firm can take proper care of the lists they receive, it becomes essential that a methodical and inexpensive system of filing be adopted, but this task becomes disheartening when so many different shapes and sizes of lists have to be filed.

There seems to be no legitimate reason why people should go in for such odd sizes and shapes, and it would appear as

though a great saving could be effected if, say, three distinct sizes could be kept:—

1. Pocket lists about 5 in. long by 3½ in. wide.
2. Quarto lists about 12 in. by 9 in.
3. A collection of lists of the same measurement, as indicated in No. 2, bound together in a strong cardboard cover.

It would not, of course, be necessary for every individual firm to publish lists of each size (*i.e.*, both Nos. 1 and 2); in fact, the only really necessary list would be that mentioned under No. 2.

It is very questionable whether so-called "pocket lists" are worth the large sums of money spent on their production, for, after all, it is useless to expect any contractor or buyer to load himself up with these things, though, of course, it may be urged that they are not published with the sole hope of their being used for the pocket, but in order that they may be readily placed in pigeon holes, &c.

In any case, however, the contents of any list of this size must necessarily be crowded and indistinct, as will be found in the majority of such lists at present published, and though they have their uses, it is extremely improbable that they are worthy of the time and trouble spent on them.

The class of list which will be found to be most useful is that mentioned as No. 2; this is the size which is very easy to file, as it will fit in any standard file such as is usually supplied for ordinary correspondence, and if the lists are sent out with holes of standard dimensions punched in the margin, it is a very simple matter to put them into their respective files.

The information contained in such lists is, of course, always very much clearer than can possibly be put in any pocket list, as it is possible to place a block print of the goods quoted for on the same page as that where the usual information concerning prices, &c., is given, without any unnecessary crowding, and the buyer knows by the print what the prices refer to.

The lists mentioned under No. 3 consist, of course, only of a collection of the various single lists published by any single firm, bound together in a suitable cover.

If, therefore, the above standards would fulfil all requirements, there seems to be no legitimate reason why they should be departed from, and if they were kept to a very considerable saving would be effected annually; but if firms persist in having special sizes of their own, then the present deplorable waste will continue, as not only will it be to a large extent impossible to file them, but it will cost considerably more to produce them, owing to the waste in cutting, &c.

There seems to be every reason, too, to adopt some standard with regard to gross prices, discounts, &c., for there is such a great number of standard articles of manufacture that it seems a great pity they cannot be arranged with standard gross prices in a similar manner to the standards adopted by the Cable Makers' Association.

There are a great many things which could be standardised in this way, such as tubing, incandescent lamps, casing, carbons, accessories, cables, &c.

If such standard gross prices could be arranged, then it would be apparent to the consumer on receipt of the discount from the manufacturers whether it would be to his advantage to place his orders with them; furthermore, it would ease the work of commercial travellers very materially, as in interviewing a customer it would not be necessary to wade through a mass of figures in order to find out his net cost—simply quoting his discount would be quite sufficient.

The compilation of gross prices with regard to the trade discount is a matter deserving of close attention, and if the gross prices were arranged so that a large discount could be quoted it would be much preferable to quoting, say, from 15 per cent. to 33⅓ per cent.; if the discount were, say, 50 per cent., then the contractor would know at a glance the net cost to him. Furthermore, if he had occasion to show the list to his customer, he could afford to allow him as a "special favour" a portion of the discount he was himself receiving, and his customer would feel an inward sense of gratification at receiving "trade terms."

It is a great pity, too, that where firms publish several lists they do not keep to a standard discount; the writer knows two or three firms who quote as many discounts as they publish lists, making it really a labour for anyone who is dealing with them to remember what the discounts are, thus leading to ultimate confusion.

Another point, the advisability of adopting which might be considered, is that of using a standard code word, each letter of which would have a certain value in discount, such as:—

D Y N A M P E R V O L T S.
2½ 5 7½ 10 15 20 25 30 33⅓ 40 50 60 70%

or any other construction of letters that would suit the purpose.

This would enable the manufacturers to mark their discounts on their lists before sending them out; the recipient would only have to refer to his standard code to interpret their meaning, and he would not have any fear that the trade discount would present itself when showing the list to his customer.

THE BRITISH ENGINEERING INDUSTRIES AND THE FISCAL INQUIRY.*

V.—Comparative Engineering Populations.

According to the summary tables, which preface the detailed information given in Section XVII. of the second Inquiry Blue Book, there are only three countries in which over a million of the inhabitants find occupation in engineering industries. These countries are the United Kingdom, the German Empire, and the United States. The three following tables are based on the three last censuses in each country:—

United Kingdom.

Year of Census...	1901.	1891.	1881.
Total number employed in iron and steel and manufactures thereof, including shipbuilding	1,249,000	971,000	834,000
Proportionate number per 10,000 of population	301	257	239
Total number employed in mining ...	839,000	707,000	550,000
Proportionate number per 10,000 of population	202	187	158

German Empire.

Year of Census...	1895.	1882.	1875.
Total number employed in iron and steel and manufactures thereof, including shipbuilding	1,115,000	808,000	732,000
Proportionate number per 10,000 of population	215	179	171
Total number employed in mining ...	430,000	321,000	283,000
Proportionate number per 10,000 of population	83	71	66

United States.

Year of Census...	1900.	1890.	1880.*
Total number employed in iron and steel and manufactures thereof, including shipbuilding	1,150,000	796,000	454,000
Proportionate number per 10,000 of population...	152	127	91
Total number employed in mining and quarrying	581,000	387,000	249,000
Proportionate number per 10,000 of population	77	62	50

*Exclusive of proprietors and members of firms in this year.

This section was prepared to a certain extent as a corrective to the injudicious practice of relying almost exclusively on import and export returns in considering the relative prosperity or poverty of an industry. It must not, of course, be assumed that the distribution of output (either in the case of the foregoing tables, or in the case of those to which subsequent reference will be made) corresponds at all exactly to the distribution of producers. For instance, the coal miner in the United States represents per worker per annum a larger output of coal than that obtained from Russia, while the Lancashire cotton operative is indubitably the superior of the negro operative whose values are now being tested in the cotton mills of Alabama and Georgia.

In regard to the detailed tables, the mining returns for nearly all the countries are exceedingly numerous, not being confined to census years only. For the United Kingdom, the number of persons engaged in coal and metalliferous

* Parts I., II., III. and IV. appeared in our issues of February 3rd and 10th, March 3rd, and April 7th.

mines are given for each year since 1871. The former have increased from 495,477 to 842,066, while the latter have declined. In regard to Russia, the figures are available for 11 years ending in 1900, for coal, gold, iron ore, naphtha, salt and other minerals. Space does not permit of their detailed examination. As regards the German Empire, detailed figures are given under seven headings since 1902. Both in regard to these figures and those from the other mining countries, it is a great pity that the yield per worker is not given. The same remark applies to the detailed returns of iron and steel workers. To know exactly how far labour may be a contributing cause to national success or national failure in the industrial warfare of the world, it would be well if returns were forthcoming as to the yield of pig-iron per blast furnace employé and the cost of labour per ton. Similar figures of puddling furnaces and rolling mills, steel foundries and tin-plate works, all of which turn out the cruder forms of iron and steel, should not be impossible to obtain. Save to note that in Russia, in 1897, 432,497 persons were employed in iron and steel and manufactures thereof; in France, in 1896, 573,058 persons; in Italy, in 1901, 205,530 persons; and in Austria 369,595 persons were employed, further quotation or comment on this section is unnecessary. Those concerned in specific industries will find much of interest in a careful study of their particular sections.

VI.—The Policy of German Kartells and Foreign Trusts.

The twenty-second section of the first memorandum and the sixteenth section of the second memorandum on "British and Foreign Trade and Industrial Conditions" have this in common, that they both portray the working of trusts in foreign countries, particularly in regard to their effect on other industries and on local consumers. The first volume contains, among other evidence, that given by officials of American trusts before a special American Industrial Commission appointed to investigate their operation and tactics. The replies evidence a supreme self-confidence in the United States and its citizens which only an American can conceivably possess. The following evidence speaks for itself:—

"Q. How do you manage to undersell the Englishman in the English market?—A. Cut his prices, usually.

"Q. You must certainly have a saving and better machinery or advantage in output?—A. The great advantage is the raw material. England's coal price is $4.50 and coke $5.50; our coal is $1.50 at Pittsburg, our ore costs less, and transportation rates on the lakes are lower than anywhere else in the world. Just now it is an exceptional time, and the demand is ahead of the supply.

"Q. In ordinary times you can keep up American wages and beat the Englishman in his own market?—A. Without the slightest doubt; we can whip him and make money.

"Q. When you take the general run, you think Americans are able to compete with the English and Germans in their own market?—A. Without the slightest doubt, and make a profit.

"Q. You can lay down steel rails, for instance, in China, cheaper than an English, or Belgian, or German firm?—A. We are doing it right along.

"Q. And build bridges in Egypt, I suppose?—A. Yes, and everything else. The truth of the matter is, the Creator of all things has been good to us. We have the raw material, the coal, the coke, the ability, the intelligence, and we are pushing it for all it is worth; and I think it is only a question of time—and a very short time—when we shall control the iron and steel markets of the world. I have one partner over there in the North-Eastern Steel Co., and another with Dorman, Long & Co., and they have absolutely given up the idea of competing with us if it comes to a close fight."

These are not the blusterings of a reporter of a New York Sunday newspaper, but the evidence given in 1899 by the president of an important company now merged into the United States Steel Corporation. While swaggering assertiveness of this order is not to be commended, it is conceivable that in a restrained form it might be more helpful to British manufacturers than the loud proclaimings of industrial decadence and imminent collapse so blithely printed by irresponsible papers seeking for a sensation. As a comment on the vehement declamation quoted, it may be mentioned that the total value of American exports of an engineering nature for 1902, three years afterwards, stood at $19\frac{3}{4}$ millions sterling, as against a British export of $56\frac{3}{4}$ millions in the same year.

The second volume contains information of a rather different order, inasmuch as boastful trans-Atlantic self-assertiveness gives place to a continuation of the evidence given before the German Commission on Kartells. Those directly concerning engineers are the Rhenish Westphalian Pig-Iron Syndicate, the Half-Finished Steel Syndicate and the Rolled Wire and Wire Nail Kartells. While the Blue-book only gives an abstract of the proceedings of the Commission, this covers such a scope as to be almost impossible of indicating in these pages. One particular point is reiterated and reiterated page after page in the evidence collected, and that is, that the system of Protection in vogue in Germany having facilitated the formation of trusts, permits a state of affairs in which semi-finished material is supplied at a much cheaper price to manufacturers in other countries than to manufacturers using the same in Germany. This, while of value to the foreign manufacturer of more highly-finished articles, reacts on the German manufacturer of the said articles in a manner which he entirely fails to appreciate as just or equitable.

"As to the price of the iron exported, little information is given; that of foundry pig is stated to have been, on the average, 4 marks per metric ton lower than that charged to the home consumer.

"By far the greater part of the evidence relates to internal matters affecting Germany, mainly complaints of manufacturers of finished goods that they cannot compete in foreign countries because German iron is sold so cheap abroad and dearer at home. Thus the Chamber of Commerce at Solingen, in its Report for 1901, complained that sheets and other materials used in making sugar shapes were sold in Belgium for at least one-third less than in Germany.

"The story of the billets lately sold at 72 marks for export f.o.b. Rotterdam (as now stated) is told again, and it is said that the same sort of billets were selling in Germany for 90 marks.

"A wire manufacturer says that, notwithstanding the export bounty on wire, the cheap sales of German raw material abroad make it impossible to export wire. This witness asserts that the 72 marks sales were on a large scale. He says that these billets came from Dortmund. The freight from Dortmund to Antwerp is about 5·70 marks. Thus the works making these billets would only have got in cash 66 marks, so that, as the price in Germany is 90 marks, with 10 marks off, if the billets are made into goods for export, the German finished-steel maker is worse off than his foreign competitor buying billets made by a Westphalian manufacturer by 14 marks a ton.

"One witness says that he has seen sheets made in Wales out of German half-finished steel; the sheets were then sent into Germany to be worked up. (These would probably be black plates, made in Germany into tinplate.)

"At the end of 1900 the *Kolnische Volkszeitung* (a newspaper unfriendly to the Kartells) stated that the wire Kartell had sold abroad large quantities of wire at prices far below the price of steel billets, and so enabled the foreign wire-nail manufacturers to maintain a fierce competition with the German nail manufacturers. This newspaper declares that the wire manufacturers in 1900 exported wire at 105 marks per 1,000 kilog. The home trade price at the time apparently referred to was 185 marks. A manufacturer complains that German wire is exported to England and is sent by England to Holland and even into Germany in the form of woven wire goods. The head of another firm, who is the business manager of the woven wire Kartell, says that a Hamburg house goes to the English manufacturers, shows them the German export prices and presses them to sell still cheaper British goods delivered at Hamburg.

"Particular objection is taken to the fact that the Kartell sells at specially low prices to foreign manufacturers goods which would, if they could be had cheap, be very useful to German industry. 'If, for example,' said one witness, 'the

Kartell sells wire nails to foreign customers at 14 marks, while in Germany we have to pay 25 marks for the same things—a difference of 11 marks—it is, at any rate, worthy of consideration whether it is not desirable to curtail the export sales, which amount to over 45 per cent. of the total production of the Kartell, and instead to promote certain of our own home industries by providing them with cheap raw materials. In its foreign trade the Kartell in the second half of 1900 alone lost £43,900, and in its home trade made a profit of £58,500. There is something here not sound.'"

The above excerpts show, of course, only one phase of the working of a Protectionist system. The exceedingly acute conflicting trade interests which are thus engendered scarcely seem to make for commercial stability. Conflicting trade interests are not unknown in Free Trade countries, but these latter are, in any case, free from certain of such glaring anomalies due to State interference as those which have been cited above.

THE WINDING OF AN ALTERNATOR ARMATURE COIL.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.,
Sydney University, New South Wales.

Replacing an alternator armature coil is more difficult if the slots are closed, or semi-closed, than when they are open. In the latter case, the formed coils are wound up ready in the works, and take only a few minutes to place in position, but with a closed slot the winding must be done *in situ*. A description of the method usually employed for winding in a closed slot may be of interest.

(*a*) The insulating tubes of micanite or pressspahn are placed in the two slots which are to be filled with wire, and wooden former blocks over which the wire is to be wound are fixed at each end between the slots.

(*b*) Strips of fibre or wire are cut off, corresponding in number and diameter with the conductors of a complete armature coil. These strips must be long enough to project about an inch beyond the ends of the insulating tubes.

(*c*) Sufficient insulated conductor wire is cut off to completely wind a coil, leaving a few inches to spare at each end for making connections between the armature coils.

(*d*) The two ends of this length of conductor wire are carefully rounded and smoothed, so that in threading it through the tubes the insulating covering of the wire already place shall not be injured.

(*e*) One of the strips is removed (the outside one nearest the air-gap being most convenient), and the wire is drawn through for half its length, the remainder being wound up into a rough coil and fixed so as to be out of the way.

(*f*) The free end of the wire is threaded through the micanite tube in slot No. 2, a strip being removed for the purpose. It is then brought back through the tube in slot No. 1 and threaded alongside the wire already in position. This goes on until half the space in the insulating tubes is filled up.

(*g*) The remainder of the wire, which had previously been roughly coiled up, is then dealt with in the same way until all the strips have been removed, and the two insulated micanite tubes are completely filled with conductors. In order to keep the wires in position at the ends, they are taped together as the winding proceeds, so that on the wooden end formers being removed the coil will hold up without support. In the case of a three-phase winding, these end formers are so shaped that the various armature coils of the three phases clear each other. When dealing with very high voltages, as, for example, 13,500 volts on the machines at Paderno, one coil comes out straight, the next is turned radially outwards, and the third radially inwards. In this way the air space between the coils where they project at the ends is never less than 4 in.

Electric Lifts for the N.E. Railway.—Messrs. R. Waygood & Co., Ltd., have secured a contract from the North-Eastern Railway Co., for electric passenger lifts at their new offices at York, Newcastle and London, as well as for the Station Hotel, Hull; there are to be seven lifts in all.

ELECTRICITY IN NEWSPAPER OFFICES.

On December 31st, 1904, the *Brooklyn Daily Eagle* started, in its new building, the last of its five new sextuple Hoe presses, all operated by electricity. These presses have a combined capacity of 360,000 eight-page papers, or 120,000 24-page papers per hour, cut and folded. Each of the presses is driven by a 50-H.P. main motor and a 10-H.P. low-speed motor. The low-speed motors are geared to attain the maximum starting pull with the minimum consumption of power, and to move the press slowly in order not to break the web. Three subsidiary motors are attached to each press for various purposes. Each press has an ingenious paper-feed, which is an innovation in newspaper practice. Lifts are provided from the basement, and are entirely automatic. There are six of these lifts, all operated from a motor-driven air compressor.

The presses are controlled on the Köhler system. Attached to each press are a number of special switches. On each switch a white button is used to put the power "on," a black button to cut it "off," and a special red button, used in emergencies, stops the machinery instantaneously in case of accident. There are also several safety buttons used by the pressmen when oiling the bearings in dangerous places. When any one of these buttons is pressed the current is entirely cut off from the motors, and it is impossible to start the press again until this particular button has been released.

Each piece of machinery in the building is driven or controlled by electricity, the total number of motors exceeding 250. All the motors are series wound, and 200 of them were installed by the Milwaukee Electric Co.

On the ninth floor is the engraving room, and a well equipped shop with two lathes and a planing machine. The lathes are driven by General Electric motors. The composing room and stereotyping department are on the eighth floor. Each of the 30 linotypes in this room has its individual motor. The autoplate machine is motor-driven, and controlled by a Cutler-Hammer controller. Between the linotype battery and the proof-reading room is a Lampson pick-up carrier, driven by a Holzer-Cabot motor. This carrier distributes proofs and copy automatically.

The editorial department is on the seventh floor, between which and the composing room are six push-button elevators, each carrying three persons. The elevators are operated by compressed air from a 15-H.P. motor. The sixth and fifth floors constitute the job printing department, where there are more than 50 flat-bed and other presses, book-binding machines, rolling machines, &c.

In the basement there are pumps of the standard triple outside plunger pocket-type for circulation and fire protection, and for the boiler feed, all motor driven. The steam-heating apparatus is the only case of steam used in the building. A 5-H.P. motor operates a machine for baling waste paper. The main air compressor is also in the basement, and is driven by a 25-H.P. Crocker-Wheeler motor. Beneath the floor in the basement is a tank built to hold 50 gallons of ink; the ink is forced by air pressure to the press fountains, and there is an ingenious filtering arrangement which can be cleaned without cutting off the ink supply. There is also throughout the building a system of piping for distributing two kinds of oil—for lubricating purposes and for washing rollers.

For passengers there are five elevators, all motor driven, and electrically controlled on the usual methods. Four are of the Otis type, and the fifth was put in by the Marine Engine Machinery Co., of Harrison, N.J. There is also a system of lifts for conveying paper and stereo plates, worked by air pressure, and pneumatic tubes to convey copy from floor to floor as needed. Throughout the office are 42 clocks, all indicating precisely the same time. These are controlled by a series of electric wires leading from a standard clock in a cabinet in the cellar.

The building is wired for 5,000 incandescent lamps. Current is supplied for the entire building from the mains of the Brooklyn Edison Co., two separate supplies being provided, at 110 and 220 volts.

On the same date as the completion of the *Eagle's* new methods, the entire mechanical and editorial plant of the *New York Times* was moved from Park Row, Manhattan, to the new *Times* building on 42nd Street and Broadway. The *Times* produced its issue for January 2nd from new electrical machinery, and has four Hoe octuple presses with a capacity of 192,000 16-page papers per hour, and 38 linotypes. Altogether there are, or will be, in the *Times* building, 109 motors, and rather more than 6,000 incandescent lamps.

BUSINESS NOTES.

Imports of Foreign Electrical Goods.—So far this year a noteworthy increase has taken place in the importation of foreign electrical goods and apparatus into this country. The returns for March last show a total of no less than £85,728, as against £68,630 in the same month a year ago, while for the first quarter of the year the imports have reached a value of £242,221, as contrasted with £208,060 in the first three months of 1904.

Change of Address.—The Testing Department of the Electrical Standardising, Testing and Training Institution has been moved to the Institution's new premises at Faraday House, 66—70, Southampton Row, W.C.

Catalogues, &c.—Messrs. Arthur Cort & Co., 277, Camberwell New Road, London. Wholesale price list of insulating hard or flexible vulcanised fibre for electrical, tramway, and general engineering purposes.

Messrs. E. Reader & Sons, Ltd, 5, New London Street, E.C.—Pocket edition of catalogue and price list of high-speed engines for direct-coupling to dynamos, blowers, and centrifugal pumps. Contains general descriptions and illustrations of various types of engines, also telegraph codes.

Messrs. J. H. Holmes & Co., Newcastle-on-Tyne. Printed list, giving in tabulated form particulars of electrical installations which they have carried out in textile mills, particularly in Lancashire and Yorkshire. The list is an imposing one, and now that textile factories are going more deeply into the question of electrification, it should serve as a valuable introduction as showing Messrs. Holmes's extensive experience in this class of work.

The Union Electric Co., Ltd. List No. VI. (55 pp.), just issued, giving very full particulars, with diagrams, half-tone illustrations, weights, prices, &c., of high-tension apparatus. Several new patterns of oil-break switch, embodying improvements since the issue of the last list, have been added. Some wiring diagrams are included of Union high-tension switches with automatic release, also of arrangements of high-tension switchboards carried out by the company.

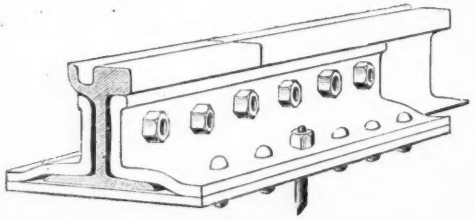
Lahmeyer Electrical Co., Ltd. Price list of their new type of small single-phase motors with slip ring and squirrel cage rotors, and fitted with Lahmeyer improved ball bearings. Also price list No. 25 devoted to high-tension oil fuses, which are largely used in central station work, one station alone having over 1,100 in use. The company has a standard size up to 12,000 volts 120 amperes for delivery from stock.

The N.S. Electric Storage Co., Ltd., Horton Kirby, Kent. New catalogue giving full description of the N.S. electric accumulator for lighting, traction, power station, and train lighting use. The illustrations include a section of the cell, the R T. type for use in train lighting in conjunction with independent dynamos, the C.I. ignition cell, and a view of the company's works. Tabulated price lists and discharge curves are given. A full description of the N.S. battery and the works where it is made appeared in the the Electrical Review for September 25th, 1903.

Messrs. Joseph Adamson & Co, Hyde. A pamphlet showing their overwinding switches for electric cranes and hoists; the list is intended to be filed with the firm's electric crane circular No. 4.

Messrs. Wenham & Waters, Ltd., Paragon Works, Croydon. New illustrated catalogue describing their Paragon "self-plugging" boxes intended for use with electric conduit wiring systems.

New Rail Joint.—The accompanying sketch, which practically explains itself, shows the construction of a new joint devised and patented by Mr. H. Booth, of 84, Parkside Road, Sheffield. The advantages claimed for the device are simplicity and strength, while it combines the functions of joint, chair and sleeper. An increased grip of the head of the rail is claimed, and



double the ordinary bearing surface where it is most needed. Thanks to the latter, a narrower rail flange may be used. A holding-down anchor bolt may be applied, as shown, if desired. The joint is applicable to both tramways and railways, and is undergoing trial on the Sheffield Corporation tramway system. It is impossible to judge of its merits by inspection; nothing but actual trial is of value, and it certainly appears to be worth putting to the test.

Ferranti, Ltd.—We are notified that the scheme of reconstruction has now been carried through, and the new company, "Ferranti, Ltd.," was registered on February 27th. The directors and principal officials of the new company are as follows:—*Directors.*—A. W. Tait, chairman (director of Messrs. Bruce Peebles and Co., Ltd); Arthur Whittaker; J. M. Henderson (director of Messrs. Thos. Bolton & Sons, Ltd.); S. Z. de Ferranti, M.I.M.E., M.I.E.E., M.I.C.E. *General Manager.*—A. B. Anderson. *Chief Engineering Staff.*—Michael B. Field, M.I.E.E., A.M.I.C.E., A.M.I.E.E., America; W. Hamilton, B.Sc., W.Sch.; C. C. Garrard, Ph. D., A.M.I.E.E. The business of the company will henceforth be confined to the manufacture of switch-gear (with all necessary accessories) transformers, instruments and meters; but in order to meet the convenience of the customers of the old company, arrangements have been made for dealing with the maintenance and repair of engines and alternators supplied by them. The eminence of the firm in the switchboard field is well known; the transformer and instrument departments have also been well developed; while the success of the company's alternating and direct current meters both at home and abroad has necessitated considerable enlargement of that department.

New Conduit Fittings.—Quite a number of new patterns of fittings for conduit installations have recently been brought out by the Armorduct Manufacturing Co., Ltd., of 6, Farringdon Avenue, E.C. Amongst these, we have selected for illustration the following:—Fig. 1 shows a distribution box, having two

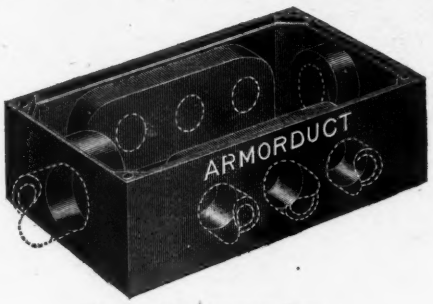


Fig. 1.—Distribution Box.

inlets and one to six outlets, these being arranged on the "knock-out" principle, so that any number of them may be used as required, without interfering with the watertightness of the box. The porcelain interior is fitted with heavy screws, and is designed to obviate the necessity of jointing; the carrying capacity is 25 amperes. The

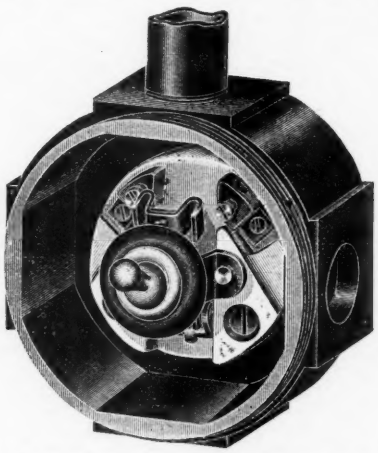


Fig. 2.—Totally Enclosed Watertight Switch.

box can be supplied ready tapped as required. Fig. 2 illustrates an improved junction box containing a high voltage tumbler switch, which can be wired in the box. A brass cap is screwed on the switch collar, and a rubber washer, forced tightly between the switch collar and the lid, makes a watertight joint. The switch is thus totally enclosed, barring the dolly, and makes a very neat job, whether exposed or flush with the surface of the wall. The same fitting can be had with art metal covers for flush mounting in living

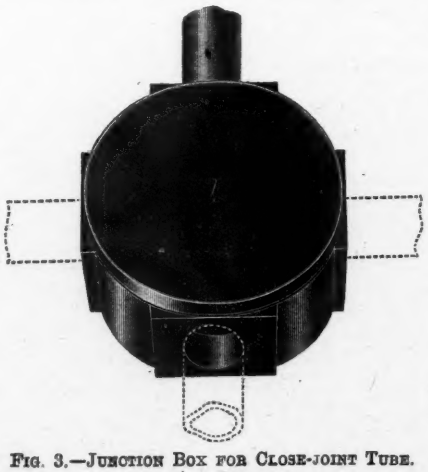


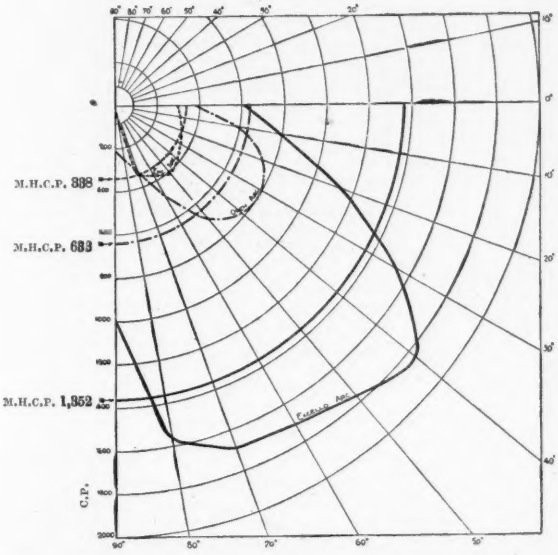
Fig. 3.—Junction Box for Close-joint Tube.

rooms, the switch being then far less prominent than the ordinary type. Fig. 3 shows a junction box of the "knock-out" type, arranged for unscrewed close-joint tube. Shoulders are provided in the interior of the "knock-outs" against which the tube abuts, forming an end bushing. Besides the foregoing and other conduit fittings, a great variety of accessories, fittings, bells, telephones, &c., is described in the list recently issued by the company.

The "Vilex" Watertight Bell.—Messrs. Siemens Bros. & Co., Ltd., York Mansion, York Street, Westminster, have introduced quite a new departure in watertight bells. Bells made up to the present for working in mines, chemical factories, powder mills, &c, have required special devices, such as stuffing boxes or diaphragms, for the outside striking mechanism in order to render them suitable for their purpose. In the one Messrs. Siemens have

just placed on the market these are dispensed with. The whole of the mechanism is contained within the gong, the latter being made to form an hermetically sealed case, into which the leads enter through a stuffing box which is not subjected to any movement. The bell can be easily fixed in any position by means of the loop at the top. From the illustration it will be seen that it is a very neat and compact device.

Arc Lamp Tests.—We have received particulars of some tests made at the Westminster Electrical Testing Laboratory, in which the "Excello" flame arc lamp was pitted against ordinary open and enclosed arc lamps. The open arc lamp was rated at 10 amperes, the enclosed lamp at 6 amperes, and the Excello flame arc lamp at 8 amperes, with the arc burning horizontally. All three



lamps were provided with alabastrine globes. The same photometer, light standard and instruments were used for all the three tests. The following are the details of the tests:—

	Open arc.	Enclosed arc.	Excello arc.
Positive carbon ...	18 mm. cored	13 mm. solid	9 mm. flame
Negative „ ...	12 „ solid	13 „ „	8 „ „
Mean current in amps.	10·8	6·25	8·7
Mean pressure in arc, volts	44·0	77·6	44·0
Mean consumption in watts ... ... (Shunt included)	476	485	382

The candle-power measurements are shown in the accompanying curves, and the mean hemispherical candle-powers were, respectively:—

	Open arc.	Enclosed arc.	Excello arc.
M H.C P.	633	338	1,352
Watts per candle ...	0·753	1·435	0·282

From the above it appears that the watts per mean hemispherical candle-power were, in the case of the "Excello" arc lamp, but 37·5 per cent. as much as with the open arc, and 19·65 per cent. as much as with the enclosed arc. The experimenters were unable to test the "Excello" lamp without globes, as its candle-power was then higher than they could measure in their photometer room; but they stated that if they assumed that the globe absorbed the same amount of light as that fitted to the open arc, the mean hemispherical candle-power without globe would work out at about 2,300 C.P. We have inquired as to the mode of measurement of the candle-power of the Excello lamp, and are informed that the values given for the vertical angles are the mean of several measurements at different angles in the horizontal plane. The results are undoubtedly remarkable.

Books Received.—*Journal of the Institution of Electrical Engineers*, No. 171, April, 1905, Vol. 34, Part 2. London: E. and F. N. Spon, Ltd. 5s.

"Syndicat Professionnel des Usines d'Electricité." Annuaire pour 1905. (10th year.) Paris: The Syndicat, 27, Rue Tronchet.

LIGHTING AND POWER NOTES.

Ashford (Kent).—The Ashford and District Electric Supply Co., Ltd., which has obtained E.L. powers for the district, has repaid to the U.D.C. the costs of obtaining the E.L. order, viz., £367.

Barton.—In view of the objections lodged by the R.D.C., the Lancashire Electric Power Co. has decided not to proceed with its application for a prov. order for E.L. The Council will apply for an order of its own.

Beckenham.—Our local correspondent states that it is now practically settled that the Council will take over the E.L. undertaking on the expiration of the lease at the end of the present year. The British Insulated Helsby Cables have held the lease since the installation of the plant a little over four years ago, and up to the present it has not been a very profitable undertaking, in fact, it has been notified that it is carried on at a loss so far as the sale of energy is concerned.

Bexhill.—The T.C. has applied for sanction to borrow £4,000 for electric lighting purposes. A L.G.B. inquiry was held into the matter on 11th inst.

Brierley Hill.—The clerk reported recently that he had been in communication with Mr. A. H. Gibbings, who acted as consulting engineer to two companies, who would be willing to take over the Brierley Hill E.L. order; he was prepared to meet the Council and place his views before it, the understanding being that the Council would not incur any costs in connection with such negotiations. Mr. Gibbings stated that in the event of the order being transferred the Council's outlay in obtaining the order would be borne by the company. Mr. Gibbings has been asked to meet the Council in committee.

Bury St. Edmunds.—The Great Eastern Railway Co. is to be approached by the Council with the object of providing energy for the railway premises at 3½d. per unit.

Italy.—A concession has been granted for the erection of a plant to utilise the water-power of the River Aterno at Raioni for generating electrical energy for lighting and power purposes.

Dorchester.—Messrs. Enright have approached the T.C., stating that they have been approached by a company who would be prepared to take over the Council's electric lighting order, provide the entire capital for the undertaking (including an amount to be agreed on for free wiring), and to repay to the Council the cost of obtaining the order; the installation to be carried out under the company's direction, the Council to have special terms for public lighting, and to have the option of taking over the undertaking from time to time. The town clerk was instructed to reply favourably to the letter.

Dublin.—The expenditure by the Port and Docks Board connection with its new electric lighting scheme is estimated at between £40,000 and £50,000. It is intended to light the extensive area along the North Wall and around the docks, which is not electrically lighted at present, and also to work all the large cranes.

Haydock.—The U.D.C. has asked the Wigan Corporation upon what terms it will supply energy in bulk under varying conditions.

Heckmondwike.—We mentioned last week the formal opening of the electricity works extensions at Heckmondwike. The original scheme was designed by Mr. W. C. C. Hawtayne, consulting engineer, and equipped with the following plant, under the supervision of Mr. G. H. Carter, who was appointed resident electrical engineer in July, 1901:—Two water-tube boilers by Messrs. D. Stewart & Co., of Glasgow, which were rejected, and are the subject of litigation; one Green's economiser of 96 tubes; one steam and one electric three-throw pump, each capable of dealing with 1,500 gallons of water per hour against a pressure of 160 lb. per sq. in.; two steam dynamos of 100 KW. capacity each, the engines being made by Messrs. Reavell & Co., Ipswich, and the generators by Messrs. John Fowler & Co., Leeds; one balancer booster set, comprising two balancers and two boosters, on one shaft, each of 13 KW. capacity. There is a travelling crane capable of lifting 6 tons, supplied by Messrs. Carrick & Ritchie. The switchboard was supplied by Messrs. Bertram Thomas, of Manchester, and consisted of three parts—positive, neutral and negative. In the battery room there was installed a Tudor battery of 270 cells, of 250 ampere-hours capacity. The cables and feeders were supplied and laid by Messrs. W. T. Henley's Telegraph Works Co.

London. For street lighting, 10 arc lamps were supplied by Messrs. Foote & Milne, of London. Fifty gas lamps were converted into electric light posts by Henley's Co.

In the beginning of 1902 the Council were called upon to make provision for a supply of energy to the British Electric Traction Co. for its tramways, which run through the Spen Valley to Dewsbury, and from time to time it has been found necessary to add to the plant. In 1902 a Babcock & Wilcox boiler and superheater were put down, an ash elevating plant by Messrs. Bennis & Co., and a Rankine feed water filter. A steam generator of 150 KW. capacity was added in the engine room, the engine being by Messrs. Howden and Co, Glasgow, and the generator by Messrs. Dick, Kerr & Co. There was also added a steam-driven surface condensing plant with Edwards air pump, capable of dealing with 10,000 lb. of steam per hour. The tanks and pipe work were supplied by Messrs. Thornton and Crebbin, of Bradford, and the cooling tower, which is of the forced draught type, was fixed by the Worthington Pump Co., the motor for driving the fan being by Messrs. Royce & Co. For tramway purposes, a Highfield reversible booster and a Chloride battery were installed. Extensions to the switchboard were made by Messrs. Bertram Thomas. Further extensions were also carried out in 1903 and 1904. These included two Stirling water-tube boilers, a generator by Messrs. Dick, Kerr & Co., coupled to a triple-expansion engine by Messrs. Howden & Co., Glasgow, a Weiss pump, a further generator by Dick, Kerr & Co., and triple-expansion engine by Willans, and additions to the switchboard. Besides the 20,467 8-C.P. lamps connected, 2,271 have been applied for, but have not yet been connected, making a total of 22,738. The capacity of the plant now is 900 KW. The B.E.T. Co. takes 400 KW.

Hunstanton.—At a meeting of the U.D.C. on Friday, the clerk informed the Council that the E.L. order expires in December next. The matter is to be considered at the May meeting.

India.—E.I.R.—The company's ferry steamers *Tara* and *Lakshoni* are to be lighted by electricity, at a cost of Rs. 20,000.

BIKANIR.—According to *Indian Engineering*, Mr. G. R. Drummond, the State mechanical and electrical engineer, has drawn up a three-phase high tension scheme for the lighting of the district. The contract has been virtually placed but not finally settled.

MUSSOORIE.—Our contemporary also states that the scheme for the electric lighting and water supply for this area will be carried out practically on the sole responsibility of the sanitary engineer to the Government, U. P. This is hardly fair to the Municipal Board, which has to provide the funds and make payments on the certificate of the sanitary engineer. Even its own engineer will be subject to the sanitary engineer, and the electrical engineer to the Government of India will not, it is said, be referred to under any circumstances in the matter.

SRINAGAR.—Major Lotbiniere is to carry out a scheme for an electric light installation for this district.

Kirkintilloch.—The T.C. has agreed to proceed with the work of installing an electric lighting system. The compulsory area alone will be touched, and energy for lighting only supplied. The estimated cost of the scheme is £2,250.

Klondike.—From the *Canadian Electrical News* we learn that the Canadian Westinghouse Co., Ltd., of Hamilton, Ont., has just entered an order for the equipment of a power house for the electrical operation of gold-dredging boats on the Alaskan rivers. A number of American capitalists recently formed the Canadian Klondike Mining Co., and after considering various plans, it was decided to install a 400-KW. generator, to be driven by a 600-H.P. Westinghouse-Parsons steam turbine. The dredgers are being built, and on these boats will be installed induction motors aggregating a total of about 500 H.P., and varying in size from 7½ to 100 H.P. The power house will be located at Dawson City, and the dredgers will operate on the Yukon River and its tributaries. Lines for transmitting power will be strung from the station to the boats, wherever they may be working.

Llanelly.—Under an agreement with the South Wales Electrical Power Distribution Co. for the transfer of the tramway undertaking, the U.D.C. is to have the option of transferring the E.L. order or to retain it and take energy in bulk from the company. The price to be charged for public lighting is not to exceed 2d. per unit added to the lowest sum which shall for the time being be charged for energy in bulk for like purposes in Wales. Should the order be transferred to the company, the Council is to pay for a minimum of 50,000 units per annum at 1⅜d. per unit, with an additional ¼d. per unit, if the transforming of the energy is carried out by the company. The charge for private lighting is not to exceed 5d. per unit, and for power 2d. per unit.

London.—ISLINGTON.—On Friday the B.C. decided to light the south-west side of Stroud Green Road by arc lamps, at an estimated cost of £800. A member, while supporting the electric light in preference to incandescent gas, expressed the belief that the Islington undertaking was over-capitalised, the machinery was out of date, and that the whole station would have to be overhauled before any headway could be made. A long debate took place on a recommendation of the Lighting Committee, that six mechanical stokers be provided at a total cost, including foundations, coal elevator and conveyor, &c., of £4,500. The Committee's recommendations were carried.

LAMBETH.—The B.C. on the 13th inst. considered a letter from the B. of T. asking for observations upon an additional system proposed by the London Electric Supply Corporation to be adopted for the supply of energy. The low pressure mains would be, it was stated, separate or concentric cables drawn into suitable ducts, or armoured and laid in the ground direct. It was resolved to inform the Board, that the B.C. had no observation to offer upon the subject.

Louth.—By 11 votes to 6 the T.C. has adopted the E.L. scheme, which was rejected at the March meeting. The scheme is estimated to cost £13,010, the suggested plant, &c., being:—Two oil engines and piping, £1,950; two 75-KW. dynamos, £480; balancer booster with starting switches and connections, £350; switchboard, connections, instruments, &c., £450; accumulators and accessories, £1,500; crane, £250; services, £800; mains and feeders, £4,000; public lighting, £1,000; fees and expenses, £1,100; foundations and silencing pit, £130.

Lowestoft.—The accounts of the electric lighting for the year ending September 30th, 1904, show a gross profit of £2,332, and a deficit, after repayment of loans, &c., of £1,471.

New Zealand.—AUCKLAND.—The City Council has adopted the report of its Streets Committee, recommending the establishment of an electrical installation in connection with the refuse destructor, the works to be planned with a view to future extension; that a permanent electrical engineer be appointed and instructed to prepare plans and specifications for such works, with an estimate of cost; and that the authority of the ratepayers be obtained in due course for raising the capital required.

Mr. P. M. Hansen, manager of the Electric Tramways Co, has, upon the decision of the Council to adopt electric lighting for the city, offered to supply energy in bulk for the purpose. In about 28 years' time the C.C. will acquire the tramways power station. The company have about 700 H.P. available for day load and after 6 p.m. about 1,000 H.P. The offer is being considered by the Streets Committee.

WELLINGTON.—The chief of the fire brigade, in a recent report on the city fires last year, states that there are a number of defective electric light installations, and favours a suggestion put forward that an inspector of electric lighting should be appointed, with power to enforce the remedying of the defects where necessary. A big fire occurred quite recently in the city, and resulted in a loss of about £100,000. This was reported to be caused through the fusing of an electric light wire, and a local paper states, on the authority of an engineer, that wiring work in the city is done in the "Yankee way," and is very dangerous.

There seems to be dissatisfaction with the electric light service supplied by the local syndicate. The company is said to be willing to sell its undertaking for about £150,000. The City Corporation, however, values the undertaking at £30,000 or £40,000, and disputes the company's monopoly. With a view to testing the whole question, the City Corporation is to arrange to supply electric light to two or three citizens. The way will then be open for the syndicate to bring a test case before the Court.

Partick.—The T.C. has agreed to extend the E.L. plant at a cost of £9,000. There had been an increase of nearly 80 per cent. in the demand for energy, while the profit on the undertaking last year was £405.

South America.—The question of lighting San Juan by electricity is now being considered, and it is expected that tenders will shortly be invited.

South Bank.—The Cleveland and South Durham Electric Power Co. has informed the U.D.C. that it intends to lay down E.L. cables and mains in the district at the expiration of a month.

Sunderland.—A L.G.B. inquiry was held on the 12th inst. into the application by the Corporation for power to borrow £15,000 for electric lighting purposes. The town clerk explained that the total was made up of the following items:—Building at Hylton Road station, £700; tower and pipe works, £850; four motor-generators, £5,960; switchboards, £1,380; mains now required, £3,700; future extensions, £2,410. The town clerk also asked the inspector to take the details of an application to borrow £5,500 for a steam alternator at the Hylton Road station. Mr. Snell, the electrical engineer, explained that the generator was required, as of the three they had, two were continually running.

Truro.—The T.C. has arranged to meet Mr. J. A. Purves, of Exeter, with regard to the proposed electric lighting scheme, and the surveyor has been instructed to inquire respecting installations in towns similar to Truro.

Warrington.—The T.C. has applied for a loan of £4,150 for electricity purposes, including the purchase of condensing plant, four mechanical stokers, pipework, and water softener.

TRAMWAY AND RAILWAY NOTES.

Beckenham.—Now that the Council has torn up its agreement with the B.E.T. Co., it is felt that a splendid bargain has been thrown away. As we have mentioned, Beckenham was to have been paid a sum amounting in the total to about £60,000 for a 30 years' lease of a tramway only one mile and two-thirds in length, which only reached half way through Beckenham. Under the agreement, the company was entitled to ask for certain modifications of the original scheme, and when the Council, at the commencement of this year, wrote to the company and asked what modifications they proposed, it was suddenly discovered that there would not be time to complete the line in the period allowed in the agree-

ment, and the Council was compelled to throw the whole scheme over. Very rashly the Beckenham Council decided to promote the Bill and also control the line, and it was this fact which gave the company the control of the fate of the scheme in the end. But this was not all. The company had agreed to pay the cost of the Bill (an omnibus Bill embodying several matters apart from tramways), and the taxed costs reached a total of £4,500. Now an agreement has been approved with the company, which allows the company to get out of the whole of its previous liabilities, to pay only "the reasonable costs of the Bill," and only of that proportion which relates to tramways, and to put on a service of motor omnibuses in the district which they can take off at the end of a month if they find that there is no prospect of motor-'buses paying in Beckenham. Had the Beckenham Council adopted the same policy as that followed in the neighbouring district of Penge, viz., allow the company to construct the line, it would have been able to hold on to its agreement, and would have taken no risk.

Belgium.—A Royal decree has been issued authorising the extension of the Ostend-Blankenberghe line between Ostend and Le Coq, and the doubling of the line between Le Coq and Blankenberghe. The capital of the tramway company is to be increased to £152,000 for the purpose of carrying out the works and equipping the line for electric traction. This summer the tramway will be worked by steam, but next year it will be operated by electricity, and the distance between the Ostend-Kursaal and Blankenberghe will be traversed in less than 40 minutes. It is proposed later on to extend the line to Heyst, Dumberghe, Knocke and Westcapelle, when it would join the line which serves the Ecluse and Breskens, in the direction of the island of Walcheren. It will be seen that the suggested connection between France and Holland —that is, between Dunkirk and Breskens—by means of an electric tramway joining the 18 stations along the Belgian coast, is in fair way of realisation.

German High Speed Railways.—In the German House of Parliament, on April 1st, the following remarks were made in the course of one of his speeches by the Minister of Railways, Mr. Von Budde:—

"I wish to say distinctly that the attitude of the Prussian Government towards high-speed railway experiments is, and has always been, both helpful and friendly throughout. I have myself travelled at the speed of 220 km. per hour. A great number of plans are now before me, especially the two projects for a line between Berlin and Hamburg, one of which is a single line and the other a double one. The Wannsee railway has been taken up again. The suburban railway to Gross Lichterfelde works admirably, as does another line, built on a different system, which runs from Spindlersfeld to Niederschönweide. The firm has now obtained a large order for a purely electric railway, Hamburg—Altona—Blankenese.

"The following lines are also under consideration:—One between Cologne and Düsseldorf, as communication between these two towns is not as quick as their friendly relations require; then one from Halle to Leipzic, and last, though by no means least, the Berlin urban and suburban line. The Government is busy with an exhaustive examination of these plans.

"Electricity has carried the day as regards passenger traffic, especially on suburban lines and where the traffic requires quick handling, but progress is not as quick as the Press would make it, and little has yet been done in regard to the application of electricity for goods traffic."

Glasgow.—At a meeting of the T.C. Mr. Macfarlane said that in view of the recent decision of Lord Balfour of Burleigh in regard to the tramway running powers to Paisley Cross, the Corporation should not proceed with the extension of the lines to Barrhead. If they went beyond Speir's Bridge there would be a loss of 3d. per mile. Mr. Alexander, the convener of the Tramways Committee, said that when they went into this arbitration, the Corporation claimed 4d. as the sum they ought to get. They had got 3½d., so that they had come out fairly well. Both the past and present managers were satisfied that they could run to Paisley at 3½d. The minutes of the Committee were approved.

Kirkcaldy.—The T.C. last week approved a minute of the Tramway Committee to the effect that no tramways extension at present be made either in the Links district or to Dysart.

Llanelly.—An agreement has been entered into by the U.D.C. for the sale of the tramway undertaking to the South Wales Electrical Power Distribution Co., which will repay to the Council £1,000, part of the costs of obtaining the order.

London.—Lambeth.—At the meeting of the B.C. on the 13th inst., the question of the Norwood trams was finally settled. The Southern Tramways Co. seeks Parliamentary powers to electrify its lines. The L.C.C. desires to acquire the undertaking, but wants the B.C. to contribute £25,000, one-third of the estimated cost of street widenings. Mr. Townsend moved that the Council's opposition to the company's Bill be withdrawn. Alderman White, in seconding, said it would be absurd to make the ratepayers give £25,000 towards the cost of street widenings when the company was willing to do all that was required for nothing. Alderman Partington said he supported the motion mainly because the electrification would be more speedily carried out by the company than the L.C.C. Upon a division, the motion was carried by 36 votes to 25. A further resolution was carried to the effect that the company be bound to observe the L.C.C. rates of pay and hours of labour for all employés. In view of the possibility of the company's Bill not passing, Mr. Bristow moved that the £25,000 asked for by the L.C.C. for street widenings be granted. This resolution was carried by a majority of one.

Great Northern and City Railway.—At 7.30 p.m. on the 13th inst., the current failed on this railway. All the stations were plunged into darkness, and the trains stopped running. This condition of affairs lasted until 10 o'clock, when the lights shone out again and traffic was resumed. The mishap caused a great deal of inconvenience, as many city workers go north from Moorgate Street between 7 and 8 o'clock. The gates of all stations were closed, and large crowds collected outside Moorgate Street. Fortunately, only one train was in a tunnel when the current ceased. This was outside Moorgate Street, and the passengers were led through to the platform without any panic. The interruption was due to a stoppage in the pipes which supply water from the canal to the boilers at the power station in Poole Street, New North Road.

L.C.C.—Proposals will be submitted by the Highways Committee of the L.C.C. immediately after the Easter vacation for the construction of the following tramway lines, which have been authorised by various Acts from 1900 to 1904:—

From Camberwell Green to the junction of Lordship Lane and Crystal Palace Road, and from the termination of the above-named line to Forest Hill.

From Grove Vale to Stuart Road.

From New Cross Road to High Street, Lewisham.

From the terminus of the existing tramways in Trafalgar Road, Greenwich, to the Blackwall Tunnel.

From Hammersmith Broadway, *vid* Putney Bridge, to Lower Richmond Road.

It is proposed, also, that the following existing tramways should be reconstructed:—

From termination of the tramways, *vid* High Street, Lewisham, to Rushey Green.

Existing line in Vauxhall Bridge Road.

Portion of Woolwich and South-East London tramways in Woolwich Road.

The total length of tramways affected is equivalent to 23½ miles of new line, and the conduit system will probably be adopted.

With reference to the tramways in North London, the Highways Committee states that, on the basis of about one-half of the tramways being reconstructed for the underground conduit system, and the remainder for the overhead trolley system, the annual mileage may be expected to reach 21,024,000 miles, and the profit on working, at 5d. a car-mile, to £438,000 a year. If provision for renewals be made at the rate of 1d. per car-mile, a sum of £87,600 will have to be deducted from the estimated profit, leaving a balance of £350,400. Deducting interest and repayment charges on the existing horse debt, £36,000; and on reconstruction for electrical traction, £216,500; there remains a balance of £97,900. The above figures exclude the question of street widenings, which are estimated to cost about £900,000. The adoption of conduit traction on the whole of the lines would involve additional capital expenditure of about £470,000, adding to the annual capital charges on the cost of reconstruction a sum of about £32,250.

New Zealand.—Wellington.—The C.C. has adopted recommendations of its electrical engineer with regard to the extension of the electrical tramways to Island Bay, Brooklyn, and Kilbirnie, and will apply for an order authorising the construction of these lines.

The Finance Committee recently submitted the following statement regarding the first seven months' working of the tramways:—Total receipts to January 31st, £25,130; working expenditure, £20,698; interest, £6,169; sinking fund, £1,517.; net deficiency, £1,146. The sum of £2,108 is placed to revenue for goods in stock.

Auckland.—The Finance and Legal Committee of the C.C. reported recently that the local auditor had recommended a claim on the tramways company for the Council's percentage of the profit (£1,700) made in 1902, and on the sum of £5,000 set aside, out of the profits in 1903, to depreciation. This was adopted.

Karori.—The B.C., with a view to securing better communication with Wellington, has accepted a scheme for the introduction of the Lombard-Guerin system of electrical 'buses. The scheme, which included the lighting of the borough by electricity, and the widening of the main roads, is estimated to cost £24,000.

Paisley.—Several complaints have been made to the T.C. in regard to the inconvenience caused to passengers in connection with the present stopping place of the Glasgow cars and the starting place of the Paisley cars, and it is proposed to hold a conference between representatives of the different tramway systems on the subject.

Partick.—Negotiations have been re-opened with the Glasgow T.C. with regard to the lowering of the level of the Dumbarton Road to allow of top-covered cars travelling through the burgh.

Pontypridd.—The Council has approached Rhondda U.D.C. with regard to through traffic on the electric tramways between Hafod and Porth, and on to the Upper Rhondda.

Poole.—At the meeting of the T.C. on Friday, it was decided to apply for a loan of £50,000 for the payment of its share of the purchase money of the Poole and District Light Railway. A similar sum will also have to be borrowed by Branksome U.D.C., and the undertaking will become the joint property of the two Councils.

On Friday last week, the final award was communicated to the authorities concerned by Mr. Justice Lawrence. He apportioned

the award as follows:—£108,000 in respect of the value of the Poole undertaking; £4,000 in respect of the other rights to be acquired by the Bournemouth Corporation. Of the first-mentioned sum, £8,000 is for the value of the rolling stock, plant, &c., which will have to be paid for by the Bournemouth Corporation; the balance—£100,000—has to be met, in equal proportions, by the Poole and Branksome Councils.

Shanghai.—The Municipal Council has decided to inquire into the question of overhead wires with a view to ascertaining, for the information of the public, that every reasonable precaution is being observed for the protection of life in the public streets in connection with the electric tramways to be introduced there.

The Council concurs in the view that the cost of removal of the world-famed Siccawei Observatory, if necessitated by the construction of a tramway system, should properly be borne in part by the Municipalities concerned.—*Indian Engineering.*

Snowdonia.—The Light Railway Commissioners, at Carnarvon on Saturday, granted the application of the Portmadoc, Beddgelert and South Snowdon Railway Co. for the conversion of two sections of their scheme into a light railway.

Taunton.—A Committee of the T.C. has reported that the six months' period for the experimenting as to the best method of roadway for the tram track has nearly expired, and next month a report upon the question will be submitted. The tramway company has agreed to run small cars, so as to lessen the noise.

The Paris Metropolitan Railway.—The total receipts of the Paris Metropolitan Railway during 1904, when the average length of the track worked was 16 miles, amounted to £826,492, as compared with £705,308 in the previous year, when 14½ miles were in operation. The percentage of working expenses to gross receipts has been as follows in the past four years, the figures also showing the percentage on including the obligatory payments made to the municipal authorities:—

	Percentage of working expenses to gross revenue.	
	Ordinary.	Including municipal payments.
1901	47·16	79·66
1902	41·48	74·04
1903	42·64	74·93
1904	41·89	74·18

The percentage in January and February of the present year was 39·18 and 71·59, with the city charges included. The line from Courcelles to Ménimontant, which was partially opened to traffic last October, was entirely thrown open on January 25th. It is expected that the city authorities will shortly hand over the southern ring line to the company, which will at once proceed with the equipment. The line, which will be ready for traffic by the end of the year, will bring the total length up to 26 miles, and thus complete the first network. As the share capital of £3,000,000 has now been entirely paid up, the company will then be able to issue bonds for dealing with the second network comprised in the original scheme.

TELEGRAPH AND TELEPHONE NOTES.

Australian Telephones.—It is stated in the *Sydney Daily Telegraph* that telephonic communication has been established experimentally between Sydney and Melbourne. In February the first connections were made, covering an entire distance of 576 miles, and the Postmaster-General had a conversation from Sydney with Mr. Jenvey, the Melbourne chief electrician. When the experimental work has been thoroughly tested, communication will be made available to the public.

Bulgarian Telegraphs.—The *Standard* Vienna correspondent says that a Bulgarian Commission has been spending several weeks there studying the Austrian system of wireless telegraphy, with the view of utilising it throughout Bulgaria, especially for military purposes on the frontiers. The Bulgarian Government are also endeavouring to arrive at an agreement with Austria-Hungary and Turkey for extending the direct telegraphic communication already existing between London and Pesth through Sofia to Constantinople. "Such an agreement would greatly accelerate and simplify the dispatch of messages, which at present have to pass over several systems."

Competition—as a Municipality Would Like It.—At Bournemouth Council meeting recently, the Telephones Committee reported the receipt of a letter from the town clerk of Glasgow, asking that a strong representation be made by municipalities, with the view of securing that the National Telephone Co. shall not be allowed to charge lower tariff rates in places in which municipalities have established telephones than the rates charged by the company in similar areas where there is no competition, and asking for this Council's co-operation with the corporations owning telephones. The town clerk was instructed to reply, stating that the Council did not consider it necessary to take any action in the direction indicated.

We have heard a good deal about the necessity of competition to break down monopoly; but the Glasgow Corporation, having deliberately entered into competition with the National Telephone Co., now seeks to prohibit the latter from hitting back. We have never heard of a more impudent and shameless demand. The Corporation would have the company's hands tied, in order that it may safely punch the latter's head!

Norwich.—Recently the N.T. Co.'s new central battery exchange was completed, and a visit of inspection was paid to it, the mayor and sheriff and other local dignitaries being present, while Sir Cuthbert Quilter, Mr. W. E. L. Gaine and others represented the company. There were 3 million calls last year.

Telephones in Japan.—Since its introduction into the "Island Empire of the East" some 28 years ago, telephony, like all other scientific industries, has made rapid strides, and the service now in vogue, although not yet as complete as in England, is well on the way to be quite as successful.

The first line of any length to be completed was between Tokio and Atami in 1888, and this was such an unqualified success, that telephones afterwards came to be generally used as a mode of communication. The next step was when the system was extended to Shiznoka, and then to Osaka, both of which lines were quite successful.

Whilst the Imperial Government recognised the usefulness of the new means of communication, it was very undecided as to whether the business should be left to a private company, or whether its development should be carried out by the State; several of the officials attached to the Bureau of the Ministry of Communication gave the matter serious consideration, and experimented in the manufacture of telephones. It was at first thought desirable to leave it to a private company, but in 1890 it was eventually decided otherwise, and the Government immediately published the Official Telephone Regulations, taking over the whole undertaking and working it as part of the telegraph enterprise. After having settled the question in this way, the Government at once started the work of extension, and in December, 1890, services were opened both in and between Tokio and Yokohama.

For some time afterwards the benefits of the service, as is usual with new enterprises, were not appreciated by the public at large; but in 1893, when telephone exchanges were also opened in Kobe and Osaka, the service began to commend itself to the merchants for use in connection with their business. In 1895 the service was patronised to such an extent that over 4,000 applications from would-be subscribers were unable to be connected owing to the limits of the accommodation, and, moreover, a number of cities presented petitions asking that telephone exchanges might be opened in their districts. As a result of this, extensive developments were resolved on by the Imperial Government, which, with the consent of the Diet, drew up a proposal whereby the sum of 12,800,000 yen (or in the English equivalent about £1,280,000) was applied towards extending the business during the next seven years. In this proposition they contemplated establishing the business in Kyoto, Nagoya, Sendai and Kumamoto, and completing the communication between these towns. The first long-distance line was opened in February, 1899, between Tokio and Osaka, and included Yokohama and Kyoto.

To show how the service has progressed since its inauguration, the following details and statistics may prove interesting to readers:—

In December, 1890—the commencing year of the Government service—there were but two exchange offices and 16 call offices, but in 1895 these had been increased to four and 24, while according to the most recent returns there are now 31 exchanges and 167 call offices. The subscribers in 1890 numbered but 343, which was equal to two persons in every 10,000; in 1895 the subscribers had advanced to 2,853, which equals 14 in every 10,000, whilst they now number over 30,000, or one person out of each 133 of the whole population. It must also be remembered that at this time there were still 23,300 people who had applied to be connected, but the work was not yet finished. Turning to the length of the telephonic circuits, in 1890, they reached 50 ri (122 miles) with the working lines extending to 331 ri (807·64 miles); in 1895, 178 ri (433·22 miles) and 2,156 ri (5,261·64 miles) and at the last return 1,039 ri (2,535·16 miles) and 43,345 ri (105,761 8 miles).

With reference to the financial side there was a balance of 2,300 yen (£230) on the wrong side at the end of the first year's working, but this has been the only occasion on which the receipts have fallen short of the expenses. The profit on the workingiof the whole undertaking now averages 1,000,000 yen (or £100,000) per annum, so that the course adopted by the Government has met with remarkable success.

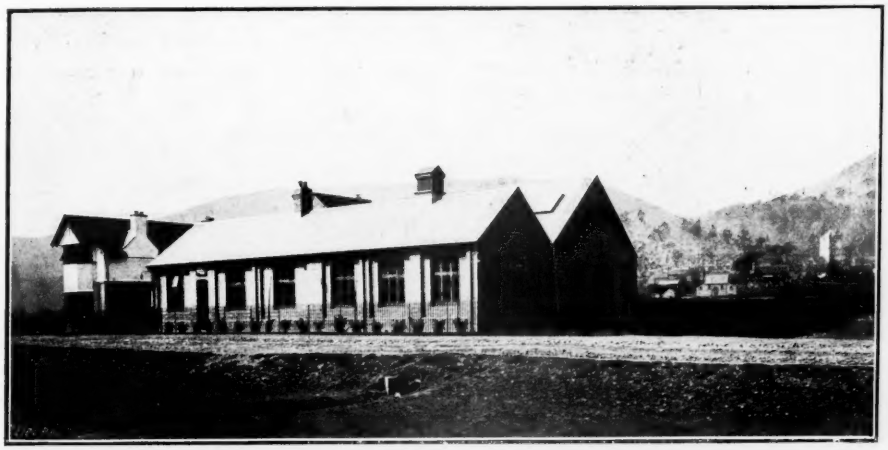
The Telegraph Cable Export Trade.—Although there was a slight improvement in March, the export trade of this country in telegraph cables and apparatus connected therewith is in a very quiet condition. The March shipments (£45,598), while showing an increase of about £18,000 over the same month a year ago, bring up the total for the first quarter of the year to only £181,335, which contrasts with £243,836 in the corresponding period of 1904, and £341,033 in the first quarter of 1903.

Wireless Telegraphy.—Considerable attention is being given by the Admiralty to the subject of establishing wireless telegraphy on the coast in connection with home defence, says the *Standard*. It is sought to secure for the Navy some measure of control over all wireless stations, but, so far, no arrangements have been entered into with the Marconi Co. to cede to the Navy in peace time the control of apparatus and stations. Better means of communication is needed between ship and shore, and it is also felt that a better organised system of wireless telegraph communication between a fortress and a ship below the horizon ought to be under naval control.

(*Continued on page* 656.)

THE CHURCH STRETTON GAS-DRIVEN ELECTRICITY WORKS.

It does not often fall to our lot to welcome with open arms "our friends the gas enemy"; but it must be admitted that in some of its numerous applications, quite outside its debatable merits as an illuminant, gas possesses certain economic advantages—such as, for instance, in the case of the suction producer gas plant here described, which, in combination with an electrical plant, forms an ideal installation for a small and purely residential district.



The Church Stretton Electricity Works.

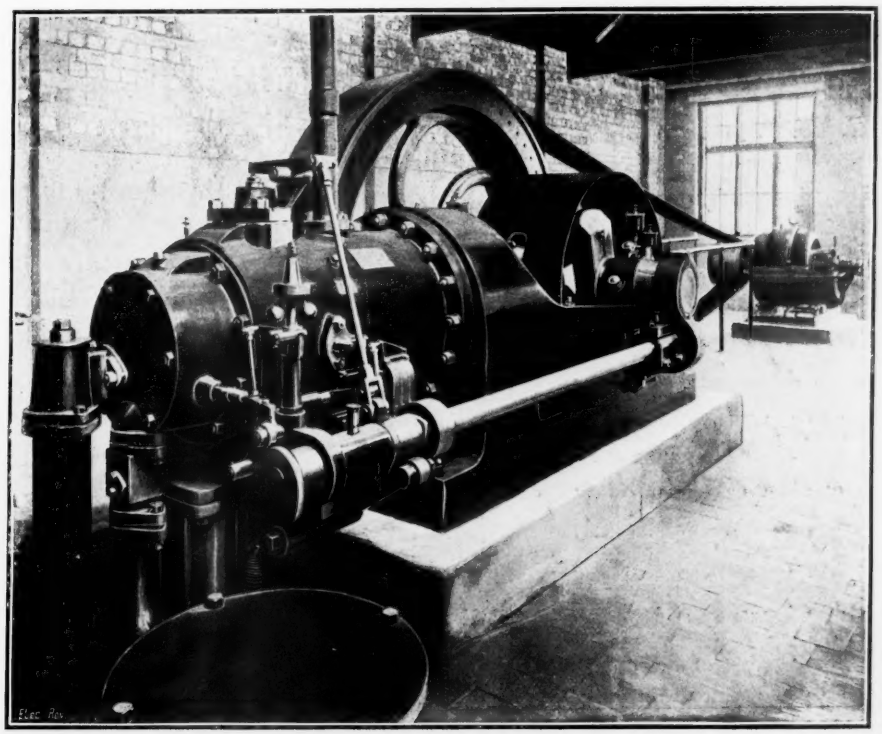
The pretty little village of Church Stretton, nestling as it does among the Stretton Hills, possesses many of the qualifications which go to make an ideal health resort. In addition to bracing air, mountain scenery and the indispensable golf links, it possesses an equally important and necessary adjunct to civilisation in its modern electricity works.

The latter is one of the few suction-gas driven plants, used for public electricity supply purposes in this country, and has been designed and erected for the Church Stretton Electricity Supply Co. by Messrs. Drake and Gorham, Ltd. The advantages of this type of plant in such a situation as Church Stretton will be fully apparent from our illustration, where the presence of a smoky factory chimney could only be regarded as a blot on the landscape.

In this case also, we are glad to say that the vibration and exhaust troubles, popularly associated with gas engines, are absent, thanks to the care taken in dealing with these matters.

The station buildings form a compact block embracing engine, producer and battery rooms, a coal store and suitable office accommodation.

In the engine room are installed two 80-B.H.P. gas engines, supplied by the National Gas Engine Co., Ltd., of Ashton-under-Lyne. The engines have a normal speed of 200 r.p.m., and are each coupled through a 14-in. belt drive to a 50-KW. shunt-wound dynamo by Thomas Parker, Ltd., Wolverhampton. The engines are provided with balanced cranks, and the connecting-rod big ends are of the marine type; the fly-wheel ends of the crankshafts are carried in outer bearings, the fly-wheels being 8 ft. 9 in. in diameter, with belt faces 18 in. wide. The engines are further provided with the Simms-Bosch system of magneto-electric ignition, and with self-starters, for filling the cylinders with gas at a moderate pressure when starting up.



80-B.H.P. High-Speed Gas Engine and Dynamo.

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The two engines are mounted on what is practically a floating concrete foundation. The latter, a solid block of concrete, rests on a layer of cocoanut fibre, 6 in. thick, which, in its turn, rests on the general concrete foundation of the engine house.

The engine foundation is also surrounded on all sides by a similar layer of cocoanut fibre, the floor, which is elsewhere tiled, being finished off above the trench with thin wood planking. By this arrangement all engine vibrations are most effectually isolated, not only from surrounding property, but also from the station buildings themselves.

Behind each engine, in connection with the air inlet valve, is an air-suction box containing a straining medium for filtering the air drawn into the cylinder.

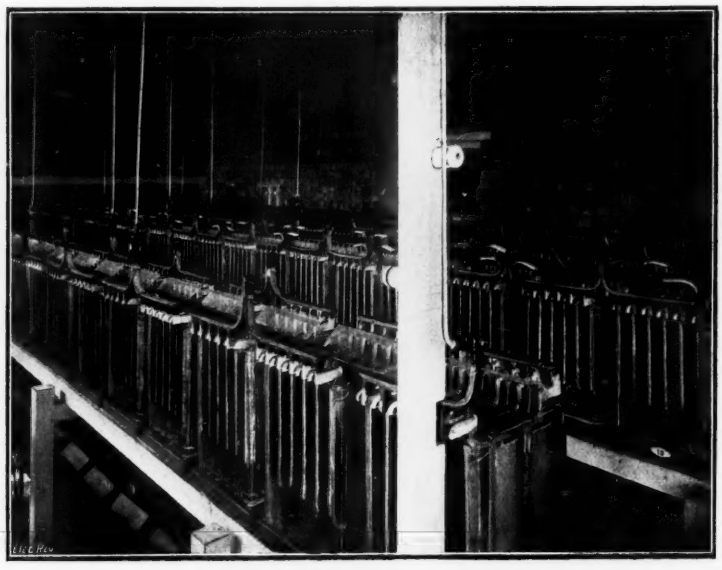
Two suction gas producer plants of the Dowson type are installed in the producer house behind the engine room. Our readers are probably familiar with the general principle of the suction gas producer, which has recently attracted so much attention in engineering circles, and it will be sufficient to say here that each Dowson plant consists of a gas generator, surrounded by a water vaporiser, and connected to a scrubber or purifier through a water seal in the base of the latter.

The fuel used is anthracite peas, the latter being fed into the hopper at the top of the gas generator, in connection with which also a small hand-driven fan is installed for blowing up the fire when starting. The steam supply from the vaporiser can be varied at will, for altering the composition of the gas according to the load on the engine.

The gas has a calorific value of about 150 B.Th.U. per cb. ft., at 0° C and 760 mm. In practice, the fuel consumption of a good gas engine served with Dowson gas is less than 1 lb. of anthracite peas per B.H.P.-hour, and only about 10 per cent. of the heat energy of the fuel is lost in the process of making a cheap engine gas.

The scrubber consists merely of a chamber containing small coke, with a water sprinkler arranged in the top; the water trickling down through the coke, cools and cleans the gas in its passage up to the engine supply pipe.

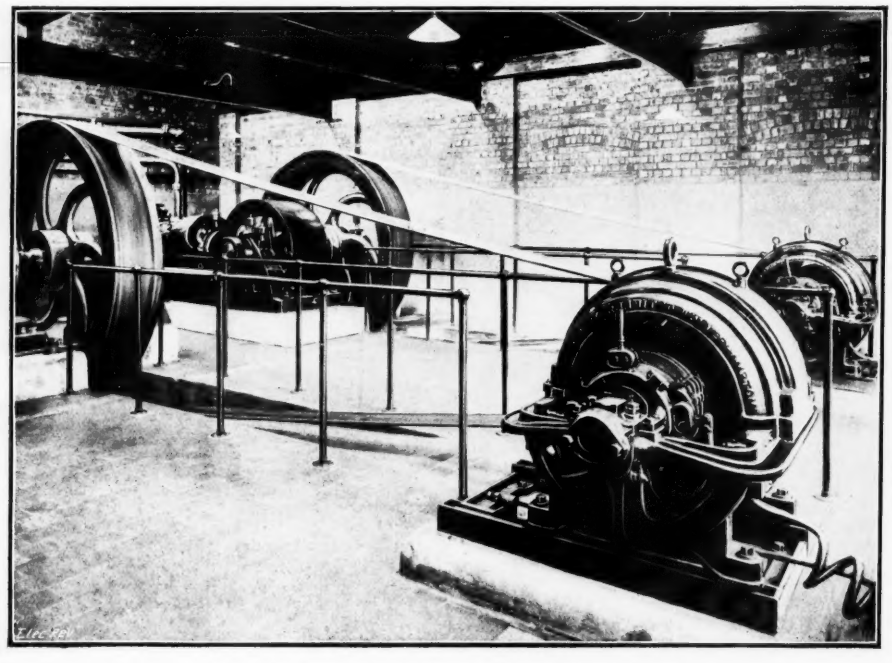
Once the requisite quality of gas is obtained and the engine started by means of the hand starter, the gas production is maintained at exactly the requisite rate, through the suction exercised by the engine.



D.P. "Station" Type Battery.

An indirect advantage arising from this system of working, is that the generator works under a negative pressure once the engine is started, and the liability of gas leakage is consequently avoided.

The other advantages of the suction producer plant, due to its dispensing with the steam boilers and gas holders, used in pressure gas plants, and also owing to the small labour attached to its use, are too well known to need a lengthy reference.



View of Engine Room, Showing Generating Plant.

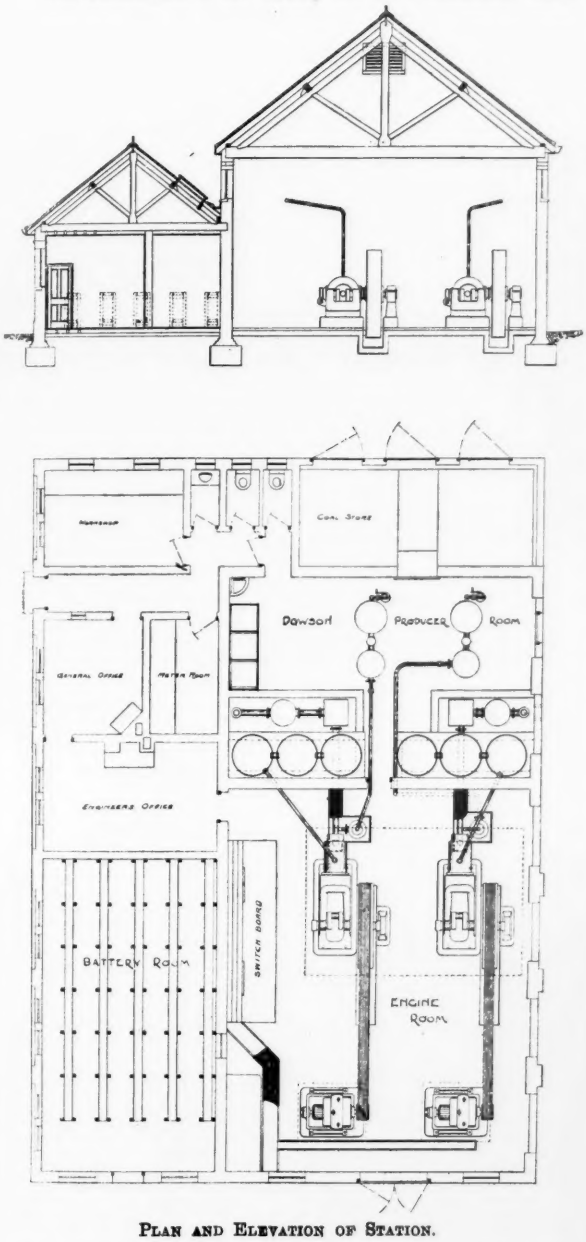
In the producer house there are also installed two large cooling-water tanks for the cylinder water-jackets, and beneath a portion of the floor, are special silencers designed by Messrs. Drake & Gorham, consisting of a combination of the ordinary cast-iron expansion box with a gravel silencer, and having vertical exhaust pipes with outlets above the building connected to them.

Returning to the electrical equipment, the Parker dynamos are of the four-pole type, mounted on adjustable bedplates; the armatures are of the slot-bar wound type, and the commutators are provided with carbon brushes. Each machine is constructed for an output of 120 amperes at 400—420 volts, with a speed of 800 r.p.m.

A battery of the D.P. Station type, consisting of 230 glass cells arranged in tiers, is installed in the battery room; 115 cells being on each side of the three-wire system on which the town distribution is carried out. This battery is capable of

supplying 220 16-c.p. lamps for nine hours without aid from the dynamos.

The connections to the battery are on a somewhat novel



Plan and Elevation of Station.

plan, which was, we believe, originated by Messrs. Drake and Gorham.

Instead of the usual motor-driven boosters run in series with the dynamo, for charging the battery, the cells are connected in parallel with the 420-volt machines, regulating switches being provided for cutting the centre cells in and out. The 420-volt supply current will charge a certain number of cells, the exact number depending on the state of charge of the battery. The remaining cells are charged by the motor-generators. By this means the battery, although always kept in circuit with the feeders, can still be charged without interfering in any way with the steadiness of the supply.

With the battery regulating switches are combined the shunt regulating switches of the motor-generators. The object of this combination is to keep the motor-generator current constant as the cells are cut in or out of circuit, the resistance in the shunt winding being increased, in proportion, as the number of cells to be charged is decreased, and *vice versâ*.

The motor-generator was also supplied by Messrs. Thomas Parker, Ltd., and consists of a 420-volt motor, with a charging dynamo coupled to either end; each dynamo has an output of 35 amperes, at pressures up to 110 volts, the speed of the combined set being 1,400 r.p.m.

The switchboard was designed and erected by Messrs. Drake & Gorham, it contains the necessary switch panels for controlling the two generators, outgoing feeders, positive and negative batteries and motor-generator, the battery charging switchgear being arranged in the centre of the board.

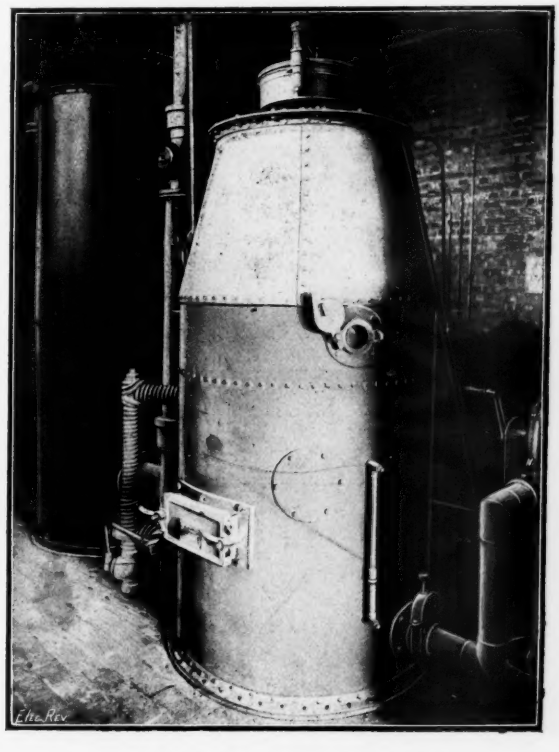
In order to facilitate the balancing of the load on the station, several local circuits supplying consumers in the immediate vicinity of the station are arranged on the two-wire system, and by means of the double-pole change-over switches on the switchboard, these circuits can, at the discretion of the station engineer, be switched in on to either side of the three-wire network, so that the usual balancer losses are avoided.

The distribution is effected by means of four concentric feeders. The cables are of the paper-insulated lead-covered armoured type, laid direct. Three-core distributors are used, the service cables being twin or three-core according to the number of lights to be connected, and the network can be interconnected or disconnected at various points as desired. The sub-contractors for the cable work were the Western Electric Co.

The station plant is capable of dealing with 6,000 8-c.p. lights, allowing for 3,000 being lighted at the same time, and we understand that the supply, which is at the rate of 6d. per unit, is meeting with considerable success. It may also be of interest to note that there is a competitor in the local gas company, which supplies the rival illuminant at the rate of 5s. per thousand cb. ft. Before closing this short description of a more than usually interesting plant, we should specially comment on the compact and cleanly arrangement of the latter, as also on the facility with which it can be started up. This well-known and valuable characteristic of the suction gas producer was demonstrated to us at the time of our visit through the courtesy of the engineer-in-charge, Mr. G. Payne.

The fuel used—anthracite peas—costs 19s. per ton at the generating station, and we gather that the fuel cost per unit sold amounts to ·41d. The plant is, of course, as yet lightly loaded, the lamp connections to date numbering 1,053.

In conclusion, we have to acknowledge our indebtedness to Messrs. Drake & Gorham, Ltd., for the facilities afforded



Dowson Suction-Producer Plant.

to us for the preparation of this article, bearing, as it does, on a type of plant which is likely to occupy a prominent place in the lighting installations of our smaller townships and villages.

REVIEWS.

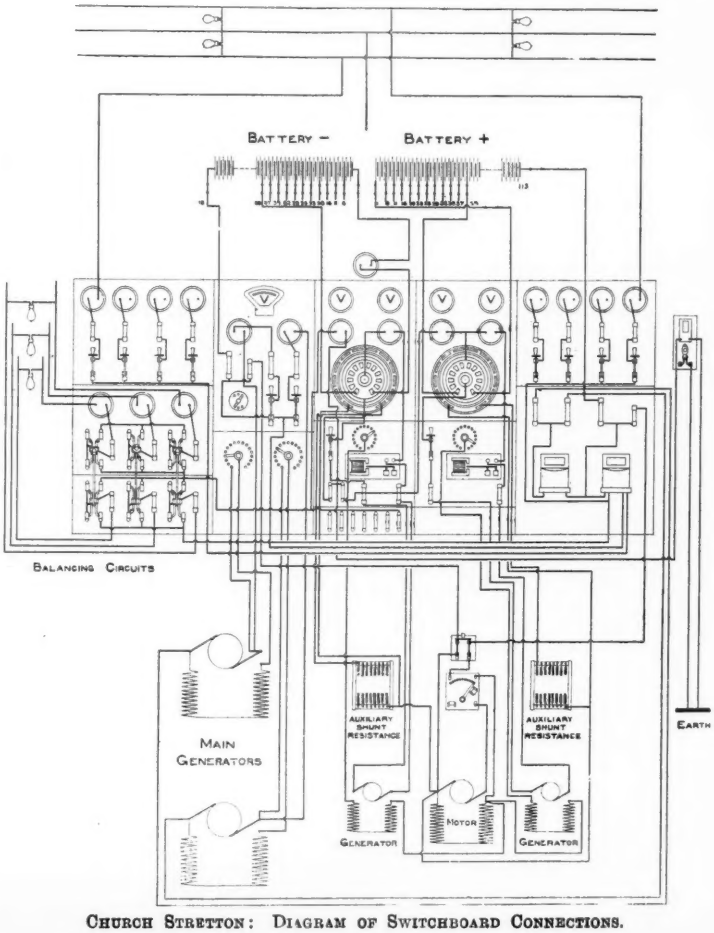
Electric Furnaces and Their Industrial Applications. By J. Wright. London: Archibald Constable & Co. 1904. Price 8s. 6d. net.

If the multiplication of books be any indication of interest in a subject, then there appears to be—shall we call it a "boom"?—in electrometallurgy just now, at least in England. We have recently reviewed in these columns the English edition of Moissan's "Electric Furnace"; there was published not long ago a new English edition of Borchers's "Electric Smelting and Refining"; and now we have the book before us which may be looked upon as the practical sequel to Moissan's famous treatise. Truly England, to use a now classic phrase, is at last "waking-up"!

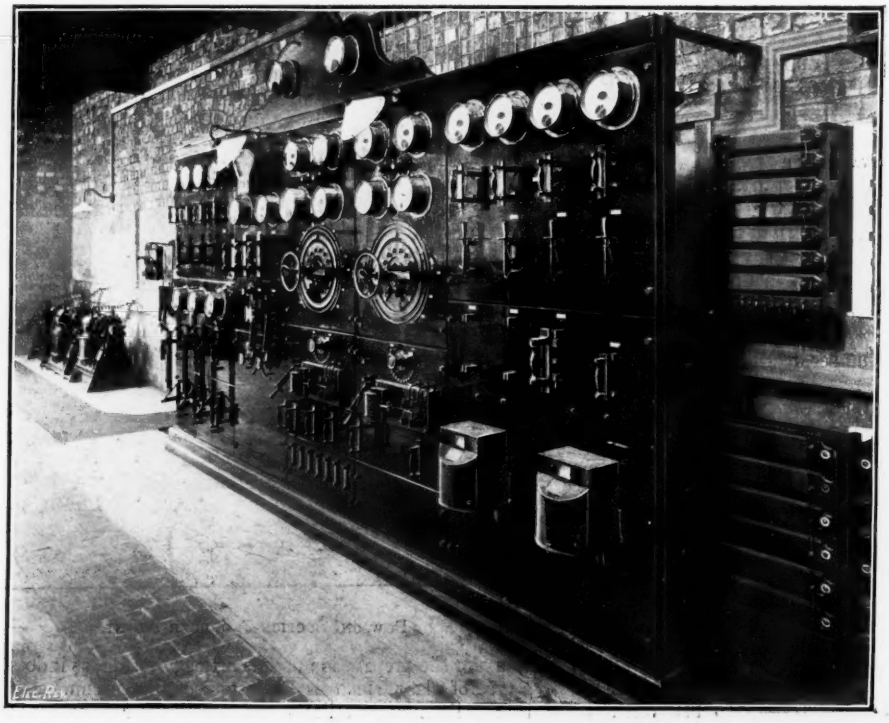
The present little volume has, like most things in this world, both merits and faults; possibly the former preponderate. We will get over the unpleasant part of the business quickly, and speak first of the faults. In a word, the book is too much of a compilation—there are too many inverted commas about—and if the author has digested all that he has read and knows, and doubtless he has, his presentation of the subject does not possess that unity which filtration through the individual personality of an author's brain should give to a book of this kind before it can be a complete success. We find, for example, too many descriptions of impossible inventions which, on the face of them, have evidently never seen more light than they can get in the Patent Office, and are certainly not in actual use. It is of the utmost importance to use the severest possible discrimination when writing a book descriptive of some phase of engineering, and no process or apparatus should be described unless it is of historical importance, is in actual practical or at least experimental use, or in the view of the writer, presents some real novelty of value.

Having said so much, we may proceed to the more gracious task of praise. Mr. Wright has collected together, and on the whole arranged well, in a very small compass, any amount of scattered information bearing on all the varied uses to which the electric furnace has been put. We feel sure that this book will prove extremely useful to the up-to-date metallurgist who is anxious to discover what is being done on the most modern side of his art, and to act accordingly, as well as to the enterprising electrical engineer desirous of enlarging the sphere of influence of his special product, the electric current.

The descriptive sections of the book are very clearly written, and quite easy to follow and appreciate. Unfortunately, we cannot say the same of the illustrations; in some of these the lettering is so indistinct as to be quite illegible, although, of course, that is not the fault of the author. More illustrations might have been added with advantage; for example, surely descriptions of important



Church Stretton: Diagram of Switchboard Connections.



Church Stretton: Switchboard and Motor-Generator.

steel-furnaces like the Keller or Kjellin — to quote stray instances—should have been accompanied by illustrations. The book has not been carefully revised; there are several glaring errors in the text, and we have noticed some omissions from the index. An index is more or less useless unless absolutely complete.

The introductory chapter is mainly historical and general, and it contains a very good section on Classification, which would, perhaps, have been more in place on p. 1. There follow chapters on arc-furnaces and resistance-furnaces, the latter monopolised chiefly by the very important Acheson group of furnaces, in which are made carborundum, siloxicon (a valuable refractory substance that has not yet attracted the attention it deserves), and, above all, artificial graphite. Incidentally we are told that the Taylor furnaces at Penn Yan, for the manufacture of carbon bisulphide, are the largest electric furnaces in use in the world; they are 41 ft. in height, 46 ft. in diameter. Section IV. is monopolised by calcium carbide, about which so much has been said that there is very little new to draw attention to here. Subsequent chapters deal with the manufacture of phosphorus and glass, although we are not informed to what extent the latter very interesting application has come into actual use. In the chapter on "Electrolytic Furnace Processes," the manufacture of aluminium and the alkali metals is described, and the section is brought up to date by an account of the Swinburne-Ashcroft process. We find here, however, little that has not appeared elsewhere, although it is, no doubt, handy to have all such information collected together in a form convenient for reference. The section on laboratary furnaces, compiled chiefly from the writings of Hutton, Howe, Moissan and others, will be found decidedly useful, and should stimulate the use of the electric furnace as an instrument of research. The treatment of the important question of efficiency is somewhat meagre; it is chiefly based on papers read by Prof. Richards and Mr. Fitzgerald before the American Electrochemical (which the author persistently spells incorrectly) Society, and that of M. Gin before the Bunsen Gesellschaft (which, in one place, is styled the Electro-Chemical Society of Cologne!). The chapter is not very satisfying or useful as it stands. Mr. Wright would have done well to expand it and treat the whole subject in a really comprehensive manner.

The production of iron and steel in the electric furnace is now attracting so much attention that the chapter on this subject is sure to be read with interest. It is a pity that the very exhaustive and valuable report of the Commission recently sent to Europe by the Canadian Government was not published before Mr. Wright's book, so that he could have embodied some of the results and opinions of the Commission. Some of the costs and energy consumptions estimated by the Commission are considerably more favourable to electric smelting than those Mr. Wright was justified in quoting. For example, the author (following Mr. Keller's paper before the Iron and Steel Institute) gives £8 12s. as the probable cost of production of 1 ton of steel by the Kjellin method, whereas this has now been reduced to £7 2s. Again, the energy required per ton of steel by the Keller process is given by Mr. Wright as 3,800 H.P.-hours (that was in 1901). Mr. C. E. Brown, the electrical engineer to the Commission, found the consumption to be only 1,095 H.P.-hours—thus rapidly is electric smelting developing its commercial possibilities. There seems to be not the shadow of a doubt in the minds of those who have made a study of the subject as to the future of electric smelting in its application to the highest grades of steel. "Steel equal in all respects to the best Sheffield crucible steel can be produced by the Kjellin, Héroult, or Keller processes," reports Mr. Harbord, "at a cost considerably less than the cost of producing a high-class crucible steel." The case of structural steel is different, because the manufacture of that would involve successful competition with processes brought to the pitch of perfection which those of Siemens and Bessemer have now reached. As regards pig-iron, the question merely resolves itself into one of comparative costs of water-power and fuel. With electric energy costing about 42s. per E.H.P.-year, and coke at 29s. per ton, the electric furnace can hope to compete with the blast furnace, and Dr. Haanel tells us that at places like Chats Falls and other localities in Ontario and Quebec there are sound reasons for believing that the electric smelting of pig-iron will actually establish itself as an industry. In the meantime, books like Mr. Wright's serve the useful purpose of reminding people of what remarkable things the electric furnace has actually accomplished in the short time that has passed since its introduction as a commercial apparatus, and this will the more easily allow them to imagine the wonderful possibilities which the future has yet in store for it.

Petrol Motors and Motor-Cars. A handbook for Engineers, Designers and Draughtsmen. By T. Hyler White, A.M.I.M.E. London: Longmans, Green & Co. 4s. 6d. net.

"Although many works," remarks the author in his preface, "exist on the subject of internal combustion engines which contain practically all that is known about them, it is thought that there is no book written entirely from the designer's point of view." His object has consequently been to provide designers and draughtsmen with reliable formulæ and information in a readily accessible form. In the first part the petrol motor and its various components and accessories are dealt with; while there will be many who disagree with the author's views on the question of horizontal or vertical engines for automobile use, he gives a good deal of useful information with regard to the subject of cylinder design, valves, carburetters, ignition, &c. At the same time we are rather afraid that the designer of motor-cars who takes up the work will not find it altogether answer all his requirements. Say, for instance, that information as to the design and dimensions of a small centrifugal governor is required, one would naturally expect to find this in Mr. Hyler White's book; but the author confines himself to the statement that "the actual design of the governor may be left to individual judgement." Other subjects which are conspicuous by their absence, and which we consider should certainly find a place in a work of this kind, relate to methods of timing the ignition, the diameters of inlet and exhaust pipes, and the correct form of cams for operating the valves, while a method of testing the horse-power of petrol motors might with advantage have been included. A similar remark may be made with regard to the second part of the work; that is to say, while the information given is exceedingly useful and practical so far as it goes, it is not sufficiently wide in its scope to thoroughly meet the object the author had in view. The subject of gear wheels is exhaustively treated, but when it comes to the question of designing a change-speed gear, we think the reader would have been greatly assisted had the dimensions of the parts of a gear box of any standard car been given. Seeing that the author himself states that driving chains of the block type are not now much employed, it is difficult to see why so much space should have been devoted to the formula for designing block chains. We believe, too, that some of the dimensions of chains given are not strictly correct—that is to say, they relate to chains of a certain pitch, and not to chains in general. Ball bearings, brakes, carriage springs, all come in for brief treatment, but in this section we note the omission of any information as to designing steering and differential gears and axles. The book extends to about 180 pages, and of these no less than a third is devoted to an appendix, in which are given a series of tables. As these, however, are mostly to be found in any engineer's pocket-book, we think that they might well have been omitted, and the space utilised for some formulæ with regard to the design of the parts to which we have drawn attention. The author's views are not in some cases in accord with what may be termed the present fashion in motor-car design; but whatever may be the ultimate outcome of the horizontal and vertical engine question, or even that of chain and chainless transmission, we hardly think that the belt drive will ever again become popular.

Taking Mr. Hyler White's book as a whole, while it does not cover the subject so thoroughly as we had expected, we can commend it as containing much that will be found useful by motor-car designers.

Chemical Statics and Dynamics, Including the Theories of Chemical Change, Catalysis and Explosions. By J. W. Mellor, D.Sc., B.Sc. London: Longmans, Green & Co. 1904. Price 7s. 6d.

This is the third volume to be published of the "Text-Books of Physical Chemistry," which the publishers are now issuing under the general editorship of Sir William Ramsay. It is a volume of 500 odd pages, divided into 14 chapters, the subjects dealt with being, according to the table of contents, homogeneous chemical reactions, homogeneous side reactions, homogeneous opposing reactions, homogeneous consecutive reactions, the beginning of a chemical reaction, heterogeneous reactions, equilibrium and dissociation, electrolytic dissociation, catalysis and theory of chemical change, fermentation, the influence of temperature on chemical reactions, the influence of pressure on chemical reactions and explosions. It will be seen that with the exception of the chapter treating of electrolytic dissociation, the contents of the present volume lie somewhat outside our purview, except in so far as the general phenomena of physical chemistry have an electrical aspect; and the chapter in question appears a trifle unexpectedly in Dr. Mellor's book, in view of the recent volume devoted to electro-chemistry, the appearance of which has already been noticed in the Electrical Review. As a whole the volume is a most satisfactory one, the various theories, or hypotheses, with which the atmosphere of theoretical chemistry is well-nigh saturated being presented in a distinctly lucid fashion; and so the student can make his choice among them—if, indeed, he were not better advised to wait patiently until the masters have made up their minds. Dr. Mellor has an easy and pleasant way of writing, which makes his meaning quickly apparent, and thus he materially assists the reader to struggle with the complexities of the subject. We wish, however, the author would not adopt the unpleasant habit of converting the names of chemical elements into adjectives.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 650.)

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostok-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chifu	Mar. 9, 1304	
Jamaica-Colon	Jan. 5, 1905	
Martinique-Paramaribo	April 2, 1905	
Medan Olehleh	April 8, 1905	April 14
Pernambuco-Para	April 6, 1905	
Maranham-Ceara	April 6, 1905	
Landlines.		
Puerto-Barrios	July 28, 1902	
Kertch-Soutehoum	Sept. 27, 1904	
Bhamo route beyond Tali	Jan. 15, 1905	
Newfoundland—all places in the interior	Feb. 10, 1905	

The Telephone Agreement.—In a report on this subject the L.C.C. Parliamentary Committee has expressed its regret that, having regard to the representations made by the Council and other authorities, opportunity has not been taken to revise the scale of charges contained in the London agreement of 1901, particularly as the rate fixed for unlimited user in the provinces is from £5 to £10, as compared with a rate of £17 for the London area. The Committee recommends that the maximum rate fixed by the agreement of 1901 between the Postmaster-General and the National Telephone Co. should be reduced; that Clause 4 (1) of the new agreement be amended so as to make it clear that no addition shall be made to the value of items other than "plant" of the company's undertaking in respect of compulsory purchase; and that the Committee be authorised to endeavour to obtain such further modifications of the proposed terms of purchase as may be desirable.

"Mercury Hammer" in Air Pumps.—At a recent meeting of the Société Française de Physique, M. Berlemont described a simple arrangement which he has adopted in mercury air pumps to prevent the constant breakage of the glass tubes by the hammering impact of the liquid when the vacuum becomes sufficiently high. At the spot where the blow is usually felt, he inserts a piece of platinum tube, about 8 in. long, fusing it to the glass tubes of the apparatus at either end.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—The Municipal Authorities of Görz are about to invite tenders for the construction of about 5½ kilometres of electric tramways in the town.

Austria.—Tenders are about to be invited by the Municipal Authorities of Debant-les-Lienz (Tyrol) for the establishment of a central electric lighting station in the town.

Bolton.—April 27th. Stores for the electricity department. See "Official Notices" April 14th.

Bournemouth.—April 29th. Feeder cables, troughing, excavation, &c., for the Christchurch tramways extension; also 11 electric cars. See "Official Notices" April 14th.

Cork.—The Cork Electric Tramways & Lighting Co. invites tenders for whitewood casing and capping.

Dublin.—May 15th. The Dublin Port and Docks Board is prepared to receive tenders for an electric generating station. Apply to Mr. John P. Griffith, M.Inst.C.E., East Wall, Dublin, for specifications &c., (deposit £5).

Edinburgh.—May 8th. Water-tube boilers for the electricity works. See "Official Notices" April 14th.

France.—May 14th. Tenders are being invited until May 14th, by the municipal authorities of Dax (Landes) for the concession for the electric lighting of the town during a period of 35 years. Tenders are to be sent to La Mairie de Dax (Landes), whence particulars can be obtained.

France.—May 15th. The Governor General of French West Africa, at Dakar (Senegal), is inviting tenders for the establishment of a central electricity station in the town, and for the construction of an electric tramway.

Fulham.—April 26th. Condenser piping; steel roof and bunker work; coal conveying apparatus for the Electricity Department. See "Official Notices" April 14th.

Govan.—April 25th. Stores for the electricity department. See "Official Notices" April 14th.

Johannesburg.—April 27th. Switchboards and accessories for the new direct and alternating current power station. See "Official Notices" March 31st.

Johannesburg.—May 7th. Tramway poles, feeder pillars, overhead material, telescopic ladders, motor tower wagon, &c. See "Official Notices" March 17th.

Lower Bebington.—April 24th. The U.D.C. invites tenders for the electric installation for Fire Brigade Alarm in New Ferry. Surveyor, Public Offices.

Portsmouth.—May 1st. Tramway stores for the Corporation. See "Official Notices" April 14th.

Rosario.—July 31st. The *Review of the River Plate* says that one of the alterations in the new electric tramways specification is the date for sending in tenders, which is now to be July 31st.

Stockport.—April 26th. One 500-kw. steam-driven generator. See "Official Notices" April 7th.

Wallasey.—April 27th. Stores for the electricity department. See "Official Notices" April 14th.

Wimbledon.—April 28th. 1,000-kw. steam-driven turbo-alternator with condensing plant, switchgear and pipework. See "Official Notices" April 7th.

CLOSED.

Lanarkshire.—Messrs. Thermit, Ltd., have obtained the contract for welding rails on the Lanarkshire Tramway Co.'s extension to Larkhall.

Lancaster.—The T.C. has accepted the tender of the British Westinghouse Electric & Manufacturing Co., Ltd., for the supply of two tramcars.

Lowestoft.—The T.C. has accepted the tender of Messrs. Babcock & Wilcox, Ltd., for the supply of a boiler with superheater for the Electricity Works, at £1,337, and that of Messrs. Dennis & Co., for cables.

Peterborough.—The T.C. has accepted the tender of Messrs. Lee & Hunt, of Nottingham, for the supply of workshop tools for the Electricity Works, at £266 4s.

Stoke Newington.—The B.C. has received the following tenders:—

Sub-Station Plant.—Twenty-two tenders, the six lowest being:—General Electric Co., Ltd., £1,924 14s.; Frank Suter & Co., Ltd., £1,996; Fuller, Wenström, Ltd., £2,039; British Thomson-Houston Co., Ltd., £2,069; Bruce Peebles & Co., Ltd. (accepted), £2,086; British Thomson-Houston Co., Ltd. (alternative), £2,121.

Switchboards.—Nineteen tenders, the five lowest being:—Ferranti, Ltd. (accepted with additions involving the increase of the tender to £1,070 10s. Similar additions would be necessary to the other schemes and tenders), £947 10s.; Electrical Trades Supply, Ltd., £1,002 3s.; Crompton & Co., Ltd., £1,008; Foxcroft and Duncan, £1,034 10s.; Nalder Bros. & Thompson, £1,128 10.

Storage Battery.—Twelve tenders, the lowest (the Electrical Power Storage Co., at £998 10s., with £68 for annual maintenance), being accepted.

Cables.—Nine tenders, the lowest (W. T. Henley's Telegraph Works Co., Ltd., at £10,133 14s. 7d., and maintenance 1½ per cent. per annum for four years after the first year, maintenance during the first year being free), being accepted.

Sunderland.—The T.C. on 12th inst. adopted the Electricity Committee's recommendation that the tender of the Phœnix Dynamo Manufacturing Co. be accepted for motor-generators; also that, subject to the sanction of the L.G.B. being obtained for leave to borrow the requisite amount, the tender of the Electrical Co., of London, be accepted for the supply of a steam alternator for Hylton Road station; and that the tender of the Vacuum Oil Co., Ltd., for oils for 12 months be accepted.

Yarmouth.—The T.C. has accepted the following tenders in connection with the extension of plant at the Electricity Works:—

Messrs. Willans & Robinson, Mather & Platt alternator	£2,358
Messrs. Babcock & Wilcox, Ltd., boiler	1,500
Messrs. G. & J. Weir, Ltd., condensing plant	1,400
British Insulated & Helsby Cables, Ltd., cables	912

FORTHCOMING EVENTS.

Thursday, April 27th.—At 7.30. Leeds Association of Engineers. Discussion.
At 8 p.m. Institution of Electrical Engineers. Discussion of Mr. B. J. Arnold's address to the Joint Meeting at St. Louis "On the Problem of the Alternate-Current Motor Applied to Traction." Mr. F. Creedy "The Alternate-Current Series Motor."
Saturday, April 29th.—Association of Engineers-in-Charge. Bohemian Concert.
Monday, May 1st.—At 7.30. Society of Engineers. Meeting.

THE POWER ABSORBED BY AIR PUMPS.

Air pumps and, indeed, condensing plant generally, receive far too little attention. Some consideration has been directed to the question by the demands of the steam turbine for better vacuum. High vacua have been condemned as requiring too much power to obtain them as compared with lower vacua, but this can only be seriously the case when the amount of air to be disposed of is unduly increased by excessive air leakage. An air pump of large size requires no more power to drive it than does a small pump, save only as regards its own friction. When working on an idle condenser, that is, one into which no further air or vapour is admitted, the air pump soon arrives at a point where no power is absorbed except by friction. The action of an air pump may be studied in this respect. Assuming the ordinary type, all the space between the bucket and the delivery valve is filled with water. When the bucket descends there is therefore generated above it and below the delivery valve a vacuum which is as perfect as it can be made in the presence of the water, which will fill the vacuum space with vapour at such a pressure as corresponds with the temperature of the water. If the bucket begins to return, it does not compress this vapour as might casually be expected, for, as soon as the space is reduced in volume, the vapour, if compressed, will become hotter than the water and will condense without change of pressure. This vacuum existing above the bucket, however, the bucket, continuing to descend, pushes the air and vapour in the condenser into a smaller volume, and their pressure being raised, a portion is compelled to pass through the valve of the bucket, so that the pressure on the two sides of the bucket is equalised. When now the bucket makes an upstroke there is both air and vapour present to suffer compression, and though the vapour may disappear by condensation into the water seal, the air will be compressed until its volume is small and its pressure is equal to that of the atmosphere. It will then commence to escape through the delivery valve, and the whole of it will escape because the water seal on the top of the bucket is filling all the clearance space. The bucket at this point has on one face the condenser pressure, and on the other the pressure of the atmosphere. If it be assumed that the pump has a stroke of one foot and the air occupies a length of half-an-inch of the pump barrel at the moment when discharge commences, then the work absorbed by the pump will be equal to that which would be given out by an air motor admitting air for half-an-inch of the stroke of a piston of the given diameter, and expanding 24 times. Owing to the presence of so much water, the expansion may probably, with close approximation to accuracy, be assumed to be isothermal, so that the mean pressure would be $p = \text{P} \times \frac{1 + \text{hyp. log. R}}{\text{R}}$, where R is the ratio of expansion or 24 in the assumed instance, and P is the initial pressure, or for air pumps 14·7 lb.; p = mean pressure throughout the stroke. Obviously where R is large, as it always should be, the value of p becomes very trifling. The net pressure against the pump bucket is, of course, less, being $p - y$, where y is the pressure in the condenser. In good tight work the ratio of the bucket stroke performed against the atmospheric pressure should be very little. It is lengthened somewhat by the amount of water to be discharged, especially in the case of jet condensers, but with surface condensers the water is small in quantity, and the air is simply that which gets in by leakage. This ought to be *nil* at high pressure glands, for they rarely have less than atmospheric pressure on the steam side. Low pressure glands are always cool, and should be fitted with fibrous packing and not wholly with metallic packing. Then if all vacuous pipes and vessels are well painted and all pipe joints made with good soft rubber rings there should be no leakage, and the air pump duty will be minimised and the power it absorbs will be simply that due to friction.

The use of a collecting jet of steam and a supplementary condenser to compel the flow of air from a high vacuum condenser into an air pump enables a small pump to do what an otherwise large pump would alone perform, and the supplementary jet enables pump friction to be reduced correspondingly with reduction of the pump diameter. But the supplementary jet will not reduce the amount of work to be done in impelling the air into the atmosphere. This work will always be the same, whatever the size of pump, for it will remain always a function of the volume or weight of air to be expelled, and no internal collecting jet can affect this quantity.

Within reason, therefore, there is no serious loss from large pumps as such, but there always is the danger that the good vacuum that can be pumped up by a large pump may lead to a neglect of leaks that would render their presence more obvious were the air pump smaller.

Thus it is that the test of a good vacuum is not so much the reading of the vacuum gauge as the length of time the vacuum will remain unimpaired when the machinery is stopped, for it is then that the air leakages make themselves more clearly apparent.

This is a test that should be regularly made, for if this test is satisfactory, the power and speed of the air pumps can be reduced to something approximating to that proper to the temperature of the condenser to which the degree of vacuum will also approximate.

NOTES.

A New Electrical Engineering Society.—For some considerable time past there has been a strong feeling on the part of the electrical engineers in the Post Office service that the great developments in every branch of telegraph and telephone engineering, and the increasing responsibilities of their position, justified the formation of a new organisation which would enable them, by the exchange of opinions on matters of interest, to keep abreast of the rapid progress in various directions; and also to remain in touch with their colleagues, scattered, as they are, over the whole of the British Isles. Until recently, however, it was not possible to pursue the matter satisfactorily, owing primarily to the heavy demands on the time and energy of the staff, which were necessitated by the establishment of the Post Office Telephone Exchange System in the Metropolis; but now that the pressure has relaxed to some extent, further attention has been devoted to the subject, and as a result a conference was held on Saturday, the 8th inst., in London, for the purpose of arriving at a decision. The conference, which was attended by considerably over 100 engineers, included the great majority of officers stationed within the Metropolitan area, and also delegates from the Post Office engineering districts in England, Wales, Scotland, and Ireland, and the latter, representing a staff of more than 200 engineers, received a very hearty welcome from their London *confrères*. The importance of the occasion was very fully emphasised by the various speakers, and appreciated by their hearers, and after a lengthy discussion it was unanimously resolved to form a definite organisation, having for its title "The Society of Post Office Engineers"; it was decided that the administration of the affairs of the Society should be vested in the hands of a president, vice-president, treasurer, secretary and a Council of eight members. The following officers were then elected, viz., president, Mr. D. H. Kennedy, A.M.I.E.E., London; vice-president, Mr. P. Jarvis, Sunderland; treasurer, Mr. J. M. Crawford, London; secretary, Mr. J. W. Atkinson, 45, Arbuthnot Road, New Cross, London, S.E. Arrangements were also made for the election of the Council at an early date, and a Sub-Committee, comprising the officers and five other engineers, was appointed to draft the rules of the Society on lines indicated by the conference. The preliminary arrangements will be completed in the course of the next few months, and it is anticipated that by the preparation of programmes of lectures and papers and in other ways the Society will be of material assistance in promoting the interests of the members.

Institution Dinners. — On Thursday last the students of the Institution of Civil Engineers held their thirtieth annual dinner at the Trocadero Restaurant, and it proved a very pleasant function indeed. Amongst the guests were Dr. Tudsbery (secretary of the Institution), and Messrs. J. Swinburne, R. Elliott Cooper, G. N. Abernethy, and R. St. George Moore. Sir Guilford Molesworth, K.C.I.E., was in the chair, and proposed the health of the "King-Emperor," after the fashion of an old Anglo-Indian and a lover of the Empire. "The Institution, the Secretaries of the Institution, and Our Guests," truly an omnibus toast, was proposed by Mr. J. W. M. Topley, one of the students, who began by throwing upon Mr. H. E. Steinberg, their hon. secretary, the whole of the credit due for the excellent arrangements made for the dinner. Remarking that it appeared to be usual, in proposing this toast, to dilate upon something entirely irrelevant, he proceeded to discuss the typical Student. When he left college he thought that the worst of the work was over, but would find that this was really the easiest; the most valuable qualities were exactly those which it was most difficult to acquire. Technical knowledge was not the end, but only a means to an end, and administrative ability was of far more value.

Sir Guilford Molesworth, in reply, said that he had been connected with the Institution for more than half a century. The adoption of the "Student" class had been of immense benefit to both the Institution and the profession. There were now over 1,200 students, of whom 300 had entered during the present session. Fifty years ago, engineers had many difficulties to contend with; enormous progress had been made in the interval. What would happen in the next 50 years? Most of them perhaps looked upon him as a "Pocket-book" engineer, but he would warn them against "that mischievous book"! They ought to master the principles underlying formulæ, instead of using them indiscriminately. Most formulæ used in practice were largely empirical, and, like type drawings, should be used with discretion and common sense.

In proposing "The Students," Mr. James Swinburne said that they were ambitious in youth, but as they grew older and less self-satisfied their personal ambition gave way to ambition on behalf of their fellows. The prosperity of the last half-century was due to engineers; there were engineering giants, like the chairman, in those days, who got along without the help of text-books. Later on, Adam Smith's ideas found their way into the heads of politicians, and they claimed that the prosperity was due to Free Trade; but it was the engineers who made the country, and the politicians grabbed the credit that was due to engineers. The snobbish idea still prevailed that it was *infra dig.* to work; hence engineers were not honoured; but he hoped by-and-by to see great changes in this respect. Without wishing to insult his hearers, he hoped that one day they would be members of Parliament—a reformed Parliament, not a political machine.

Mr. H. Steinberg, hon. sec, briefly replied, and ascribed the engineers' effacement to their well-known and excessive modesty.

During the dinner and toasts a programme of music was performed by Farban's Viennese Band; and afterwards "The Follies" delighted the guests with their amusing repertoire. There was no doubt that the evening was generally enjoyed.

The anniversary dinner of the Institution of Mechanical Engineers was held on 13th inst. at the Hotel Cecil. The chair was taken by the President (Mr. Edward P. Martin, of Leeds).

Control at a Distance by Electric Waves.—Prof. Branly (*Comptes Rendus*, March 20th) has invented an apparatus for producing a series of effects such as explosions, lighting lamps, or starting electric motors from a distance by electric oscillations like those used in wireless telegraphy. The succession of effects is variable at will. The distributor consists of an insulated axis, on which are mounted metal disks rubbing on brushes and springs for the passage of an electric current. The axis is moved by clockwork, and each disk is an interrupter corresponding to an operation that it starts or stops. There is a wireless telegraph from the distant place, which informs the operator what circuit he is about to act upon. The coherer used is of the tripod and disk type, and the wireless telegraph Morse apparatus is protected by a metal cage.

Preparation of Alkali Metals by Electrolysis.—An American patent has been taken out by Messrs. Baker and Burwell, for a process of obtaining alkali metals in the following way. An alkali salt is electrolysed with a mercury cathode, so as to produce an amalgam. The amalgam is heated in presence of hydrogen till an alkali hydride is formed and the mercury volatilises. The mercury is used over again in the electrolytic cell, and the metallic hydride is decomposed to yield the free metal.

The Year's Fires in London.—The chief officer of the London Fire Brigade has just issued his annual report, showing that in the 12 months under review there were 3,161 fires reported in London. Of these 68 are reported as due to defective electric circuit, 1 to overheat of electric light, and 1 to electric light coming into contact with film. There were 148 fires caused by escape of gas, and 5 by gas explosions, while altogether in connection with gas in one form or another no fewer than 405 fires occurred. Two fires occurred on the premises of electricians, caused by a swinging gas bracket and wax boiling over. There were 6 fires at electric lighting works caused as follows:—Defective electric circuit, 4; overheat of furnace flue, 1; unknown, 1. Four fires occurred to electric tramcars on the road, all caused by defective circuits, and 7 fires on the premises of electrical engineers, which were due to the following causes:—Experimenting with chemicals, 1; overheat of gas stove, 1; light thrown down, 4; and unknown, 1.

Appointment Vacant.—An engineer of large experience in the design and manufacture of main central station switchgear and controllers, is required.

Cricket.—The Electrical Trade Unionists (London district) have formed an athletic club under the title of "Eltradion," the name of the official journal of the society; they would like to arrange cricket matches with clubs connected with electrical firms (25 weak). All communications to be addressed:—Thomas Grover, 108, Hall Road, Peckham, S.E.

International Railway Congress.—At the International Railway Congress, which is to be held at Washington this year, the British Government will be represented by Sir Francis Mowatt, Sir Francis Hopwood, Lieut.-Col. H. A. Yorke, and Messrs. W. H. Macnamara and W. M. Acworth.

Max Margowski.—A further sitting of the London Bankruptcy Court was held on Monday, before Mr. Registrar Hood, to inquire into the history and failure of the Automatic Telephone Co. (1903), Ltd, and for the further examination of Mr. Max Margowski. That gentleman was not present, however, and Mr. H. Brougham, Senior Official Receiver, said he had been unofficially informed that he had left the country, but he had no evidence on the point. The examination was practically concluded at the previous sitting, the adjournment being ordered chiefly to enable Mr. Margowski to be re-examined by his counsel. Mr. E. G. Festing volunteered to give evidence, and stated in reply to the Senior Official Receiver, that he had acted as secretary of the company, under the direction of Mr. Max Margowski He had acted throughout under the directions of Mr. Margowski whom he believed to be a thoroughly straightforward man. In his capacity of liquidator, he drew two cheques for £2,500 and £650 respectively in favour of Mr. Margowski who had previously paid £3,150 into the same banking account. Witness understood that Mr. Margowski claimed £5 000 for out-of-pocket expenses, and that this £3,150 was in respect of that claim.—Mr. Frank Dobb, on behalf of shareholders, also examined the witness, and suggested that as Mr. Margowski's solicitor was in Court, he might desire to make a statement regarding his client. That gentleman, however, said that he had no statement to make, and his Honour closed the inquiry.

General Electric Co. of America and Japan: Important Development.—The General Electric Co. of America, who already have a large connection with Japan and the Orient generally, have just completed arrangements with the Tokio Electric Co., Ltd., in order to start a factory in Tokio for the manufacture, on a large scale, of the Edison incandescent lamps, under the American patents, which have been re-issued in the Orient by the Japanese Government Patents Office. In future, the whole of this portion of their manufacturing business and Oriental markets will be conducted in Tokio. A considerable amount of American capital is to be put into the enterprise and the business largely developed. The Japanese portion of the company will remain entirely under Japanese control.

Lightning.—On Sunday afternoon St. Mathias Church, Richmond Hill, was struck by lightning, which followed the electric light wiring, destroyed the switchboard and broke many incandescent lamps.

Glasgow Tramways.—The Tramways Committee of the T.C. has refused to reduce the price at which energy is supplied to the electricity department of the Corporation from 1d. to ¾d. per unit. Coplawhill car works are to be extended.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—The Electricity Committee of the Pudsey T.C. has recommended the appointment of Mr. E. Denton, of Prescot, as electrical engineer. There were over 100 candidates.

The Hove T.C. on Thursday last week appointed Mr. G. M. Harris as resident electrical engineer at the Aldrington E.L. Works at a salary of £156 per annum.

On Saturday last the Manchester Corporation sub-stations department staff presented Mr. G. P. Turner, sub-station inspector, with a marble clock and engraving on the occasion of his marriage. The presentation was made on behalf of the staff by Mr. E. Bolton, the sub-station's engineer.

Tramway Officials.—The Perth T.C. has appointed Mr. Lambert, the electrical engineer, to be tramway manager as well, at a salary of £350.

At a dinner given to the employés of the old Gorleston and Yarmouth Tramways last week, the late manager, Mr. Groves, was presented with a pair of bronzes. Mr. Groves is now in the service of the B.E.T. Co., at Croydon.

Mr. E. Hatton, the newly-appointed tramway engineer at Newcastle-on-Tyne, received a warm welcome to that city on April 12th. To meet him the employés were entertained in the Corn

Exchange by the Mayor and Mayoress (Alderman and Mrs. Joseph B. Ellis). Mr. Ernest Hatton, on relinquishing the position of manager of the Salford Corporation Tramways, was presented with a gold watch by the motormen and conductors, a travelling kit bag from the overhead equipment staff, a Chippendale clock by the permanent way staff, a silver inkstand by the inspectors, and a spirit cabinet by the office staff.

The Southampton T.C. has, by 24 votes to 20, appointed Mr. Street, electrical engineer, as tramways manager at an increase of £150 per annum on his present salary. The Tramways Committee had recommended Mr. Yerbury, deputy manager of the Sheffield Corporation Tramways, for the post, at a salary of £500 per annum, rising to £600. There were 50 applicants for the office.

General.—It is stated in *Indian Engineering* that three years' extension of service has been granted to Mr. Kirk, director-in-chief of the Indo-European Telegraphs.

In consequence of the resignation of Mr. W. F. Hosgood, resident engineer and locomotive superintendent of the Port Talbot Railway and Docks Co., the following appointments have been made:—Mr. W. Cleaver to be engineer, Mr. A. H. Hertz to be locomotive superintendent.

Mr. L. B. Schlesinger has been elected chairman of the National Electric Construction Co.

Indian Engineering says that Mr. S. H. C. Hutchinson, Director-General of Indian Telegraphs, has been granted three months' leave from April 1st next, Mr. E. H. Leach officiating for him, while Mr. F. E. Dempster has taken the latter's place as Deputy Director-General, his own post of Director, Construction Branch, being filled by Mr. C. S. James.

Mr. T. Commerford Martin sailed on Wednesday on his return journey to New York.

Obituary.—As we briefly announced in our last issue, the death took place on 6th inst. at Hailey House, Wallingford, of Mr. John Verity, J.P., chairman of Veritys, Limited. Mr. Verity, who was only 41 years old, had a nervous breakdown in November, and went to stay in the Chilterns for his health. After deriving much benefit from the change and rest, he caught a slight cold, which, becoming more serious, brought about the end on the date stated. In spite of a constitution far from robust, Mr. John Verity possessed tireless energy, and he has achieved much in his short life. He was educated at the University College School, and after spending four years on the Continent he went to America, where he saw much of Mr. Edison at the time when incandescent electric lamps were still a laboratory production. Returning to England, he joined the firm of B. Verity & Sons, which was originally founded by his grandfather in about 1820. The firm were pioneers of the gas industry, and in the early days put down many important gas plants and installations in different parts of the country. In the early eighties this firm was one of the first to recognise the future of electric lighting, and is amongst the few firms still existing who exhibited at the Crystal Palace Electrical Exhibition in 1882. Soon afterwards, upon the death of his uncle, the business came under the control of Mr. John Verity, who, from the first, devoted his energies to the progress of electrical work. As electric lighting developed, Mr. Verity turned his attention to manufacturing electrical material upon a large scale, and in 1891 the works which had hitherto been at Covent Garden were removed to Aston, near Birmingham. These works were further enlarged in 1896, when the manufacture of electric motors was commenced, and they were again extended last year when the firm commenced the manufacture of motors and dynamos of larger sizes. We understand that every detail of organisation came personally before the late Mr. Verity. Recognising the future that lay in store for supply undertakings, he was, in company with the late Sir John Pender and Sir George Elliot, instrumental in forming the Metropolitan Electric Supply Co. At the time of his death, though the youngest director of the Metropolitan Co, he was the only one of the original directors remaining upon the board. Mr. Verity was a J.P. for the County of Warwick, and was High Sheriff of the County of London four years ago. He married a daughter of Mr. Henry Lubbock, of Newberries, Herts., who, with four children, survives him. Though such a hard worker, Mr. John Verity found time for recreation. He was a good man on the links, and a fearless rider to hounds. To his intimate friends—and they are many both in business and social circles—his loss is irreparable. Those who worked with him many years will find a void in their lives which will take long to fill. The direction of the company's affairs is left in the charge of his brother, Mr. George Verity and his colleagues, who are likewise his personal friends, and who have all been associated with him in working the business up from its inception as an electrical manufacturing firm.

Col. Renard, the famous military balloonist, died suddenly last week at the aerostatic establishment of Chalais-Meudon, outside Paris, of which he had long been director. With his brother and Capt. Krebs, Renard invented an airship long before M. Santos-Dumont was heard of.

NEW COMPANIES REGISTERED.

Dundee, Broughty Ferry and District Tramways Co., Ltd. (5,885).—This company was registered in Edinburgh on April 4th, with a capital of £90,000 in £1 shares, to purchase or otherwise acquire the control of the statutory rights and powers under the Dundee, Broughty Ferry and District Tramways Order Confirmation Act, for the construction and working of certain tramways in the county of Forfar, to construct and maintain any tramways or any railways in the United Kingdom or elsewhere, and to carry on any business incidental or auxiliary thereto. The first subscribers (each with one share) are:—W. Brownlee, Dundee, builder; E. Cowan, 4, High Street, Dundee, solicitor; D. W. Wybrants, Tighnduin, Monifieth, merchant; P. Wild, 37, Trafalgar Road, Greenwich, clerk; G. Boyd, 63, Castle Street, Edinburgh, solicitor; M. Edwards, 5, New Court, Lincoln's Inn, London, solicitor; and G. Balfour, Woodville, Bromley, Kent, A.M.I.C.A. The number of directors is not to be less than three nor more than seven; the first are D. W. Wybrants and W. Brownlee; qualification, £200; remuneration, £100 per annum for the chairman and £50 for each ordinary director.

Adelaide Electric Supply Co., Ltd. (84,209).—This company was registered on April 10th, with a capital of £300,000 in £5 shares (30,000 preference) to carry on in Australasia and elsewhere the business of electrical and general engineers, electricians, contractors, carriers of passengers and goods, wharfingers, agents, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, generators, accumulators, transmitters, users and suppliers of light, heat, sound and power, by means of electricity, galvanism, magnetism, compressed air, gas, steam, oil or otherwise, constructors of cables, wires, lines, accumulators, lamps and works, &c. The first subscribers are:—J. B. Braithwaite, jun., The Highlands, New Barnet, stock and share broker, 20 ordinary shares; A. F. Farish, Worcester House, Walbrook, E.C., solicitor, 20 ordinary shares; J. Harold, 13, Baskerville Road, Wandsworth Common, S.W., accountant, 1 ordinary share; J. A. Scrimgem, The Cottage, Gatton, Reigate, gentleman, 1 ordinary share; A. G. Greig, 17, Parliament Hill Road, Hampstead, N.W., clerk, 1 ordinary share; G. Aylwen, 43, Howard's Lane, Putney, S.W., clerk, 1 ordinary share; and W. E. Lane, Finsbury Pavement House E.C., secretary, 1 ordinary share. Minimum cash subscription, one-third of the shares offered to the public. The number of directors is not to be less than three nor more than seven; the first are J. B. Braithwaite, jun., A. F. Farish and R. P. Sellon; qualification, 20 shares; remuneration, £50 each per annum and 5 per cent. of the dividend paid on the ordinary shares, divisible.

Indian Electric Supply and Traction Co., Ltd. (84,233).—This company was registered on April 11th, with a capital of £600,000 in £5 shares, to carry on in India and elsewhere the business of electric engineers, electricians, general engineers, contractors, manufacturers, constructors, dealers in electrical appliances, cables, lines, wires, accumulators and the like, suppliers of electricity for light, heat, motive power, and other purposes, tramway and railway proprietors, &c. The first subscribers (each with one share) are:—C. Atkinson, 20, St. Helen's Place, E.C., merchant; H. R. Clayton, 20, St. Helen's Place, E.C., clerk; G. V. Nicholls, 3, Ballater Road, Brixton, S.W., clerk; E. D. Kilburn, 14, Christ Church Road, Hampstead, N.W., clerk; W. Crawford, Kilcreggan, Cheam Road, Sutton, Surrey, clerk; W. Matthews, 94, Trevelyan Road, Tooting, clerk; and H. J. Owens, 15, Prince's Avenue, Church End, Finchley, N., clerk. Minimum cash subscription, 800 shares. The number of directors is not to be less than three nor more than seven; the first are A. P. Simpson, D. Cruickshank, W. H. Cheetham, and J. G. B. Stone; qualification, £1,000; remuneration, £300 per annum for the chairman and £200 each for the others, with a share in the distributed profits (such share not to exceed £2,000 dividend in any year). Registered office, 20, St. Helen's Place, E.C.

F. W. Dickinson, Ltd. (84,249).—This company was registered on April 12th, with a capital of £4,000 in £1 shares, to acquire the business of an electrical engineer, roundabout and switchback maker and show furnisher, carried on at 43 and 45, Hunslet New Road, Leeds, by F. W. Dickinson. The first subscribers (each with one share) are:—F. W. Dickinson, Shaftesbury Avenue, Street Lane, Leeds, electrical engineer; F. Dickinson, Shaftesbury Avenue, Street Lane, Leeds, electrical engineer; W. Balmforth, 4, Leicester Grove, Blackman Lane, Leeds, electrical engineer; J. Gordon, Bond Street, Leeds, chartered accountant; W. H. Clarke, 12, South Parade, Leeds, solicitor; E. Cookson, 2, Ashville Terrace, Cardigan Road, Leeds, clerk; and J. R. Cheesebrough, Bond Street, Leeds, clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the first are F. W. Dickinson, F. Dickinson and W. Balmforth; remuneration as fixed by the company. Registered office, 43—5, Hunslet New Road, Leeds.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Ingleton Electric Lighting and Power Co., Ltd. (60,796).—£400 debentures, created January 27th, and dated April 4th, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, subject to prior debentures, for £3,200, have been filed. Holders: A. H. Dean, 37, King Street West, Manchester; and W. M. Harris, Kendal, Westmoreland.

Anglo-Portuguese Telephone Co., Ltd. (24,545).—A trust deed, dated March 4th, 1905, to secure £50,000 5 per cent. mortgage debenture stock, has been registered. The company covenants with the trustees to execute and do all necessary instruments and acts in Portugal to charge the company's telephone undertaking, and charges (as a floating security) its other assets, present and future, including uncalled capital. Trustees: W. R. Davis, 10, Moorgate Street, E.C.; and H. Allen, 88, Chancery Lane, W.C.

Cambridge Electric Supply Co., Ltd. (36,457).—Particulars of £30,000 debentures, created by resolution, dated December 2nd, 1904, have been filed, pursuant to Sec. 14 (4) of the Companies' Act, 1900. Property charged: The company's undertaking and property, present and future, except uncalled capital. No trustees.

Typewriting Telegraph Corporation, Ltd., London (66,332).—Issue, on March 22nd, of £100 debentures, part of series created November 14th, 1904, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £640.

Auto-Electric Rifle and Target Co., Ltd., London (76,336).—Issue, on March 22nd, of £2,650 debentures, part of series created December 5th, 1904, to secure £5,000, charged on the company's property, present and future. No trustees. Previously issued of same series: £1,150.

Newmarket Electric Light Co., Ltd. (44,450).—This company's annual return was filed on April 6th, when 2,345 shares had been taken up out of a nominal capital of £30,000 in 3,000 shares of £10 each. £23,450 has been received. Mortgages and charges: £14,200.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders are issued for next week:—

There will be no Technical Instruction at Headquarters until Monday, May 1st.
Monday.—Headquarters closed.
Tuesday.—"B" Company. Recruits' drill, 6 p.m. Medical Inspection for Recruits and Special Service Section, 7 p.m.
Thursday.—"C" Company. Company Drill. Parade at Headquarters, 7.45 p.m. Rifles and side arms. Plain clothes.
Friday.—"D" Company. Recruits' drill, 6 p.m.

Wilfrid C. Dumble, Captain R.E.
For O.C.E.E.R.E. (V.

ELECTRIC TRAMWAY ACCOUNTS.

Liverpool Corporation Tramways.

The comprehensive returns of the Liverpool Corporation tramways undertaking for the year ending December, 1904, are to hand. Our tabulated results, gleaned from this source, show the progress of the tramways department since the 1903 report was issued.

General Statement.

For 12 months ending December 31st.	1904.	1903.
Length of route	53 miles	53 miles
Total length of track	103 „	103 „
Average number of cars in use	398	407
Car-miles run	12,165,419	11,724,097
Passengers carried per annum	116,642,663	113,015,728
Capital expended to date	£1,916,258	£1,863,485
Traffic receipts	£540,850	£524,468
Total receipts	£547,625	£531,484
Working expenses	£367,845	£341,464
Gross profit	£179,780	£190,020
Income per car-mile	10·67d.	10·73d.
Working expenses per car-mile ...	7·25d.	6·98d.
Interest and sinking fund per car-mile	2·14d.	2·19d.
Total expenses per car-mile	9·39d.	9·17d.
Profit or loss per car-mile	+1·28d.	+1·56d.
Cost of energy per car-mile	1·87d.	1·65d.
Average fare per passenger	1·112d.	1·113d.
Average length of penny stage ...	2⅓ miles	2⅓ miles
Revenue per mile of route	£10,332	£10,030
Expenditure per mile of route ...	£6,940	£6,443
Total units used	20,045,129	17,978,718
Units used per car-mile	1·56	1·45
Percentage of working ex'es to receipts	67 %	64·25 %

Profit Statement for 1904.

Interest on loans	£53,748
Sinking fund	£54,969
Reserve, renewal and depreciation account	£54,218
Contributed to the rates	£27,109
Gross profit (including £10,264 interest accrued during year)	£190,044

Taking into consideration the magnitude of the undertaking, and the excellent service of cars mentioned, the financial results obtained, are well up to the level of former years.

The passengers, running receipts and car-mileage are each approximately 3 per cent. higher than in 1903, but with increased working expenditure, to the equivalent of ¼d. per car-mile, the available surplus, after meeting financial charges, the latter being decreased in the average, shows a reduction of ·28d. per car-mile, compared with the previous year.

Including in the revenue some £10,264 interest, derived from moneys invested by the department, the gross profit becomes practically the same as in 1903, and the available surplus, after meeting financial charges, ·05d. per car-mile higher than in that year.

Analysis of the cost of working under electric traction for the years 1903 and 1904:—

	Per car-mile, 1904.	Per car-mile, 1903.
	d.	d.
Maintenance and renewal of cars and fittings (including new lifeguards, ventilators, emergency boxes, signal bells, &c.)	·842	·775
Maintenance of tools and machinery	·026	·023
Maintenance of sundry stock	·014	·012
Repairs to sheds, &c.	035	·035
Electrical energy—haulage, lighting cars, &c. ...	1·872	1·657
Road and traffic expenses—		
Salaries—Wages to drivers, conductors, inspectors, &c.	2·390	2·490
Gravelling, &c.	·027	·035
Cleaning, &c., of cars	·181	·190
Cleaning and lighting sheds, &c.	·049	·050
Lighting routes	·002	·003
Tickets and punches	·040	·047
Repairs, &c., of knee aprons	·0008	·004
Licenses	·008	·008
Advertising, printing and stationery	·018	·016
Uniform clothing, bags, &c.	·086	·070
Sundry charges	·046	·052
Maintenance and renewal of lines	·495	·432
Do. electrical equipment ...	·094	·095
Acknowledgements for privilege of affixing rosettes	·003	·003
Rental of lines in Bootle	·115	·119
General charges, including rates and taxes, management and office expenses, compensation and law charges, &c.	·902	·852
Total	7·256	6·978
Interest and sinking fund	2·144	2·188
	9·400	9·166

Owing to the growth of the undertaking, the department has had to acquire a site on which to erect new tramway offices, the contracts for which have been placed.

During the year the total number of emergency calls in connection with the overhead equipment amounted to 553; the fatal accidents due to people getting in front of or under the cars amounted to 6, or 1 in every 19,440,444 passengers carried, it being noted that 123 persons fell in front of or were knocked down by the cars, but were sheered clear by the plough guard with which the Liverpool cars are equipped.

In regard to car wheels, the joint report to the tramways committee on July 15th, by the engineers and general manager stated:—

"The wheels of the German cars, which were the first to be used in Liverpool in 1898, were steel tired, and the wheels of the American cars which followed, were chilled cast-iron.

"The steel tires 'spread' in running, became loose, and out of gauge, and were ultimately abandoned in favour of the chilled wheel, which was giving much better results on the American cars.

"The British manufacturers commenced the production of special steel tires for tramcars about 1900, when their experimental use in competition with chilled wheels began.

"These experiments were carefully watched, and in May, 1902, a number of selected tires were placed in service in Liverpool, and later it was considered desirable to try tires of all the representative makers. Fifty-two of the cars are now fitted with steel-tired wheels, none of which have yet worn out, and, therefore, final figures cannot be quoted. Very divergent results have, however, been obtained, the mileage per unit of wear varying to the extent of 50 per cent., indicating the importance of selecting tires of suitable composition.

"As a result of the experiments carried out for the last two years, a steel-tired wheel is now being assembled and finished at Lambeth Road works, which will cost 50 per cent. less than the price at which such wheels can at present be bought, and which it is believed will afford a life considerably in advance of the average of these wheels, which may be estimated at 60,000 miles, the average mileage of chilled wheels in Liverpool being 35,000."

Since the date of that report over 100 cars have been fitted with new wheels, which are giving satisfactory results, and the work of general equipment is proceeding.

The total number of cars fitted with top covers and in service amounts to 317. As showing the effect of the top cover, it is pointed out that the average maximum number of cars in service during 1904 was 398, against 407 during 1903, while the passengers carried increased by 3,585,429.

Other matters touched on in the report are the through booking agreement with the South Lancashire Tramways Co. between St. Helens, Prescot and the Pierhead, the receipts on this section showing a slight improvement over the previous year.

The Tramways Committee's scheme for constructing special routes for the conveyance of merchandise between the Docks and the South Lancashire Co.'s terminus at Knotty Ash, is apparently still in abeyance, and the projected additional routes in Bootle are in much the same position owing to differences between the Bootle and Liverpool Corporations.

CITY NOTES.

Metropolitan Electric Tramways Co.

The ordinary general meeting of this company was held on Friday at Salisbury House, Finsbury Circus, Mr. E. Garcke in the chair.

The Chairman, in proposing the adoption of the report, said he would first refer to the tramways and light railways which they held, and he was glad to say that during the past year they had been successful in opening up various important routes, and they were now working about 15½ miles of tramways and light railways by electric traction. About 3 miles had been opened since the issue of the report. They were still operating about 1½ miles by horse traction. During the past year they had carried about 9½ millions of passengers by horse cars, and about 7½ millions by electric cars, or a total of something like 17½ millions of passengers. On the horse lines their average receipts were 10·8d. per car-mile, but on the electric lines their receipts averaged about 13·3d. per car-mile, and taking the receipts per route-mile, they appeared in this way: For the horse lines they were able to take about £8,000 per mile per annum, while on the electric lines they were taking close about £14,000 per mile per annum. That figure was specially interesting when he was able to tell them that it was very much better than their estimated figure. The figure upon which they calculated their revenue was about

£12,000 per mile. They were still busily engaged in completing the conversion of the remainder of the horse lines, and the Middlesex County Council were constructing—and they (the company) were equipping—various light railway routes, and it was hoped that about 4½ miles of light railways would be opened before Whitsuntide, on the Great North Road from Highgate to Finchley. An important arrangement had been made with the L.C.C. The present horse tramways in the direction of Highgate Archway fell short of the commencement of their light railway by about half a mile, and it was very important indeed to complete the link. They had been able to arrange with the L.C.C., who would construct immediately a piece of line and lease it to them, so that they would be able to start their electric cars at the point where the present horse-cars terminated. Another very important piece of work which they hoped would be in operation within the course of the next few months was the lines direct to the Alexandra Palace. They had two important lines running right up to the Palace. They were about 3 miles in extent, and he had no doubt they would be a great convenience to the public and a source of profit to the company. Arrangements had been made with the local authorities of Wood Green and Edmonton, providing for an extension of the company's tenure of the lines in those districts, so that these local authorities would not exercise their powers of purchase until 1930. In the case of Wood Green they had agreed to carry out a certain street improvement, but in the case of Edmonton the arrangement was rather more complicated. Hitherto they had only been able to work a single line here, which was a great inconvenience in dealing with heavy traffic, and it had become necessary that they should have a double line. For this purpose certain street widenings had to be carried out, and they were promoting a Bill in Parliament this session to sanction the acquisition of the necessary properties to make these widenings. In the course of the negotiations with the Middlesex County Council, it appeared advisable to that authority that the streets should be widened somewhat more than the company was bound to widen them, and an arrangement had been made which would relieve the company of the burden of providing the necessary capital expenditure for the widenings. The Middlesex County Council would carry out the whole of the widenings, and would charge the company interest on their share of such expenditure at the rate of 4½ per cent. With regard to their investments in other companies, he would first take the North Metropolitan Tramways Co., in which they held about 78,000 shares out of a total of 110,000 shares. That company operated under a lease from the L.C.C., and the Metropolitan Electric Tramways Co. received an average dividend of about 3¾ per cent. on their investment in the past year, which he was glad to say nearly paid the dividend on their preference shares. No doubt they had seen in the Press the proposal which the Highways Committee of the County Council had made to purchase the unexpired term of the lease held by the North Metropolitan Co. Although of course this was a matter of great interest to them, still it did not at present come before them officially. He could not state what precise financial bearing this would have upon them, but practically the effect was to anticipate the normal course of events. If the lease were continued until 1910, of course they would continue to receive their dividends at about the rate he had mentioned, and at the end of that time they would receive the payment in respect to the sale of horses and cars to the L.C.C. It was very probable that a delay in the electrification of these tramways would lead to very difficult questions with the Council, but at the same time it was an exceedingly difficult matter to arrange for the conversion of the lines to electric traction, especially with the conduit system, while the lease continued, and, personally, he thought that the L.C.C. were well advised in coming to the conclusions that it was decidedly in the interests of everyone to anticipate the normal course of events. With regard to the Paddington and Harrow Road Tramways, their holding in that was something like 4,600 shares out of a total of 6,300. For the past year they received 4 per cent. on their shares, and the Bill which was promoted in the last session of Parliament for the purpose of confirming their purchase of that undertaking, and carrying out the conversion to electric traction, was passed, and they were now in the position of being virtual owners of the undertaking, and they felt the importance of losing no time in the electrification of that line. The directors were very seriously contemplating taking the necessary steps with a view of doing the work at an early date. Of course, it meant the raising of some additional capital, but the sooner capital was expended for such a purpose, the sooner profits would be earned. There were other reasons why it was very desirable that the electrification of the Harrow tramways should not be delayed. They had obtained an extension of the purchase powers until 1930 so far as that portion outside the L.C.C. area was concerned, and the portion inside London became purchasable in 1907, but they would be compensated for any expense incurred in the electrification of that part of the line, and they considered the right policy was to proceed with the electrification as quickly as possible. As to the electricity supply business, they had invested £228,000 in that, and large as that sum might appear, he would point out to the shareholders that the important character of the work carried out by the Electric Power Co. would involve a still larger employment of capital. They had no doubt whatever but that that investment would in course of time be as profitable, if not more profitable, than the tramway and light railway department of the company. Power supply was now recognised not only as a sound business capable of very enormous development, but the evidence put before the Parliamentary Committee which had just been considering the various power schemes indicated that there was a general consensus of opinion amongst electrical people that this power supply business ought not to be neglected. They occupied a very favourable position with regard to the various schemes being promoted. As they were aware, some very ambitious schemes were in course of development, and the electric light companies in London were giving their serious attention to power supply. He was glad to say that it was recognised by the promoters of the Administrative County of London Bill that their company was very well situated for doing that particular work in their district, and Mr. Merz, the chief engineer for the Administrative County schemes, had left them free from competition in their area. The company enjoyed a very favourable position for supplying local authorities in bulk at very low prices, and he was convinced that local authorities would do well before embarking on the erection of generating stations to consider the question of buying from them. They had large power houses at Brimsdown and Willesden, and the whole of the best area of 360 sq. miles could be supplied. They were supplying their own tramways and light railways, and some local authorities, and were negotiating with others. Hitherto they had devoted themselves to supplying electricity in bulk, but the British Electric Traction Co. saw the scope there was for supplying electric light, and they had formed a company to undertake to supply under provisional orders at Enfield, Barnet, Hertford, and sundry other places. They had felt it desirable to take over that company, and also a little company which had been formed at St. Albans. The total traffic receipts from the tramways amounted to £81,800; the dividends from investments were £25,300; and other receipts brought the total up to £113,200. The running expenses were £64,200; and the cost of the North Metropolitan debentures which they guaranteed were £5,200; and they had had to pay £10,400 in the issue of their own debentures. Shareholders would like to know that a year or two ago the various tramway companies decided to form a mutual insurance scheme against accidents, because of the excessive rates charged by the insurance companies. They joined in this scheme, and, therefore, their insurance against accidents would be effected upon the basis of actual cost. The balance of profit was £32,200. The preference dividend of 5 per cent. absorbed £25,000, and they had been able out of the balance to discharge the balance due to the British Electric Traction Co. in respect of the advances which they made to make up the deficiency on the preference shares in previous years. They carried forward £3,854. They were now on a thoroughly sound basis, and no longer had the protection of the British Electric Traction Co., and must look to their own profits for payment of dividends. He entered upon that stage with every confidence that he would be able to meet them with a satisfactory dividend in the future. They were carrying on a very big business capable of very large development, and it would be necessary to raise capital. The policy of the board had been only to raise capital when it was required, and the next issue they proposed to make was one of ordinary shares of about £140,000. As they looked upon that as being worth more than par, it would not be quite fair, perhaps, to offer it to the public, and they proposed to offer it to the shareholders and debenture-holders as nearly as possible at the rate of £1 for every £10 at present invested in the company. Although no dividend had yet been paid on the ordinary shares, he felt that time was not far distant when one would be earned and paid.

Sir E. Spencer, M.P., seconded the motion, and the report was adopted.

Windsor Electrical Installation Co.

On 5th inst. this company held its annual meeting at Windsor, Mr. H. L. Prior presiding.

The Chairman moved the adoption of the report, which showed that 3,139 8-c.p. lamps had been added, making a total of 31,025, which included 2,362 for motor power. The capital expenditure to date had been £68,381; the gross revenue for the year was £11,484, and the net profit, after providing for interest on loans, was £4,486. £1,000 was placed to depreciation, renewal and reserve; £200 is transferred from the dividend equalisation account to net revenue; and the total dividend for the year is 7 per cent. The Chairman said that they had purchased a large number of units from the Slough and Datchet Co., and £1,452 was paid therefor. The price per unit payable to the company was to be reduced this year. Rates and taxes had greatly increased. The installation department had gone ahead, and was now full of business. The only new undertaking in hand at the moment was the lighting of Old Windsor. They had applied for an order for Clewer and Old Windsor, but, owing to opposition, they had abandoned the Clewer portion of it. The company had been working with too little capital for some time, and their bankers had been very kind. They were now about to issue 20,000 5 per cent. preference shares (out of a proposed 50,000) at one guinea each *pro rata* to the shareholders.

The report was adopted, and the resolutions as to dividend and new capital were approved.

Bruce Peebles & Co.

Mr. C. M. Peebles presided at the meeting of the company held at East Pilton on March 31st. In moving the adoption of the report, an abstract of which appeared in our issue of March 31st, the chairman went briefly into the figures given in it, and congratulated shareholders upon the result of the year's working, particularly bearing in mind that all the expenses of removal from the old works and starting the new ones, had been charged against revenue. The

directors felt that by paying 6 per cent. dividend, and placing the remainder of the profits to reserve, &c., they were strengthening the position of the company. In addition to the ordinary work of electrical manufacture, they had on hand several large contracts for the complete installation of tramway and power plants. These contracts had been obtained at favourable prices, and, in addition to providing a large amount of work for the shops, the directors had been able to make arrangements for the remainder of the work being carried out for the company on favourable terms. One item in the balance-sheet was debentures and shares in power and traction companies, valued at £17,370. It was sometimes necessary, in connection with large contracts, to take a certain participation in shares or debentures of the contracting companies as part payment of the contract price. The preliminary expenses stood at £8,431, as against £10,431 last year. This amount was being still further reduced by the application of £4,000 out of the profits for the year, and it was hoped that, in the course of another year, the remaining balance would be written off. When the original issue of capital was made, for the purpose of building new works at East Pilton, it was anticipated that the capital expenditure in connection therewith would only amount to £53,000. The actual amount spent up to December 31st, 1904, was over £93,000, and it was, therefore, necessary that they should have additional capital to make up this difference, and to provide further working capital. The directors, therefore, exercised the borrowing powers conferred upon them by issuing £50,000 debentures, bearing interest at 5 per cent. The debts due by the company were £119,823, as against £28,749 last year. The large increase in this item was mainly due to the contracts which the company had on hand for the erection of power and traction plants. A further cause of increase in this item was the rapid extension of the business, whereby it had become necessary to supply further working capital. In the report it was stated that the turnover was more than double that of the previous year; to be correct, it was 2⅜ times, or, in money value, a total of £338,735. The new works at East Pilton were completed early in the year, and work was commenced there about the end of February. Of course, owing to the change from the old works to the new, and to the installation of new machinery, a considerable amount of time was lost for manufacturing purposes; it might, therefore, be said that the profits of the year were practically made in nine months' working, as against a full 12 months in the previous period. A considerable amount of money, in addition to what was originally anticipated, had been spent in building and equipping the works, but the directors considered that the result of the year's working fully justified the expenditure. In the prospectus issued in June, 1903, it was stated that when the new premises were in full swing, it was anticipated that the profit might be doubled, which would mean £26,000 per annum, and it was, therefore, very gratifying to find that the results of the first year in the new works had more than fulfilled that hope. The increase in trade of the year 1904 over that of 1903 was being maintained in the current year so far, and the company now had on its books orders which showed a large increase over the corresponding period of last year. 1904 was marked by a wave of severe commercial depression, but the outlook for the present year was considerably brighter, and the financial markets were easier, and it was, therefore, reasonable to expect that trade would receive a considerable impetus during the current year. The electrical industry suffered, perhaps, as much as any other industry in the country, but, with the return of commercial enterprise and prosperity, it would undoubtedly receive its fair share of the general development of business. The growth of the business had been beyond all anticipations. The proceeds of the proposed new issues would be applied entirely to providing further working capital, and by this means the company would be placed in a very strong financial position.

The report was adopted.

Woking Electric Supply Co.

The report for 1904 shows a total revenue of £10,357, and a net revenue of £4,325. After paying 4½ per cent. on debentures, 6 per cent. on the preference shares and 5 per cent on the ordinary, and placing £1,000 to depreciation, a balance of £715 remains. There are now 783 consumers (an increase of 123 for the year) with 29,566 lamps connected. During the year new share capital and debentures had been issued, and the directors now want to issue the balance of these. This was necessitated by reason of the increased demand which occasioned alterations to the power house, and also by the proposed extension of the area of supply for which an application is now before Parliament.

Prospectuses.—The Adelaide Electric Supply Co., Ltd., has been before the public with an issue of 10,000 6 per cent. cum. pref. shares of £5 each at par. The list was due to close on Wednesday, April 19th. The company has been formed to take over the Adelaide and Port Adelaide undertakings of the Electric Lighting and Traction Co. of Australia, Ltd.

The Dundee, Broughty Ferry & District Tramways Co. is inviting subscriptions until 22nd inst. for £40,000—5 per cent. mortgage debenture stock, 50,000—6 per cent. cumulative preference shares, and 15,000 ordinary shares. A report by Mr. Stephen Sellon as to probable earnings accompanies the prospectus.

STOCKS AND SHARES.

Monday Evening.

Broken by the holidays at the end of it, the week opened with very little promise of business. Prices so far have been well maintained, but that there should be a lack of public interest in Stock Exchange matters is only what might have been expected at this season of the year. Hence the brevity of the following story.

Some of the nervousness engendered amongst investors by the Power Bill for London is already being allayed. Westminsters have recovered 10s. to 13, and the earlier spreading of the scare to shares in the West End companies showed how little the scope of the proposed enterprise is understood. It is the concerns operating within what is called the "Industrial Area" which stand to be principally affected. Of the shares in these undertakings, the only one to show any change this week is South Metropolitan Ordinary, the price being a few pence easier at 1⅜. But Edmundson's Ordinary are duller at 6, although this, of course, is really a provincial business! Other lighting shares have not moved, and the only alteration amongst Debentures is a point rise in County 4½ per cent. stock. In the Miscellaneous Section a ¼ fall in Crompton's brought the price to 2⅛. We understand that the new issue of Bruce Peebles Preference, to which we referred last week, has been postponed until immediately after the holidays, when, by the way, there are many other new things to be offered to the public. The recent Adelaide issue has been favourably regarded.

On the new Ordinary shares of the Metropolitan Electric Tramways a premium of 3s. 9d. has already been established, and Traction descriptions, as a whole, are good. British Electric Ordinary moved up ¼ to 9½, and London United Tramways Preference have hardened to 10½. The anticipation that the recent unsatisfactory report would bring in sellers of the shares has not been realised, and we can only add that the improvement provides an excellent opportunity for shareholders to realise at a good quotation.

Calcutta Tramway shares are 8⅜, *ex* 5s. dividend, and Calcutta Electric Supply are 9½. Both prices, remarked a member of the Stock Exchange, are "somewhat earthquakey," a phrase which, if not euphonious, carries considerable meaning. Anglo-Argentine Ordinary at 8½ and Belgrano Ordinary at 3⅜ are *ex* 5s. and 2s. 6d. dividends respectively, the prices being slightly easier. Cape Electrics, on the eve of what is likely to prove a most important meeting, keep quietly at 30s.

Electric Power stocks and shares will soon demand separate sections in financial price lists. The market in most of them is narrow enough at present, because the companies are not sufficiently developed to attract much popular attention. South Wales Power Ordinary are 8¼ and the 5 per cent. Debenture stock is 110. Yorkshire Electric Power are about £6 for £10 fully-paid shares, but the new West Ridings are hardly mentioned yet. County of Durham New Preference have further risen to ⅜ premium, and the Ordinary are about ¼ premium. We understand that the issue received a very cordial welcome. Kent Power 4½ per cent. Debentures are 92½. In a rather different class we may mention Kalgoorlie Electric Power Preference, which have fallen to 15s., a drop of about a shilling.

Beyond a few declines caused by dividend deductions, the Telegraph list is still featureless. Anglo-American Deferred at 15¼ is ⅜ down, speculators for the rise having been closing part of their commitments prior to the recess. Cuba Telegraph Preference receded 10s. to 17, although the island's railways are coming into fair demand, and Cuban securities mostly move on the same plane. Globe Telegraph Ordinary eased off ¼ to 10½, but Reuters continued their buoyant tone with another 5s. rise to 8¼ middle.

Railway issues are little influenced by the holiday prospects. City and South Londons at 44 have again dropped ½, but Baker Street and Waterloo Debenture shot up to 3¾ premium after the special settlement. Metropolitan Consolidated is 97, and District 40½. There is no fluctuation to record in the Central London trio.

Manufacture of Electrodes for Accumulators.—A German patent has been obtained for a process of improving the conducting power of the granulated graphite, which is mixed with a metallic oxide, in the composition of the electrodes of certain accumulators. The fragments of graphite are put into a basket made of fine nickel wire, which is plunged into an electro-nickelling bath of the usual composition, a plate of metallic nickel being laid at the bottom. This forms a feeble cell, with the basket as cathode, and in a short time the pieces of carbon are covered with a brilliant metallic layer. It is advantageous to agitate the basket at intervals, so that the thickness of the nickel deposited may be uniform.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1903.	1903.	1904.	Closing Quotations April 12th.	Closing Quotations April 17th.	Business done week ended April 17th, 1905. Highest	Lowest
34,800	African Direct Telegraph, 4 % Debs.	100	4 %	4 %	4 %	99 —102	99 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	2¼ — 2⅜	2¼ — 2⅜	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,350 Red.	100	Nil	Nil	Nil	72 — 77	74 — 77	..	..
763,580	Anglo-American Telegraph	Stock	60/6	61s.	22½%	61 — 63	60 — 62 xd	59⅜	..
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6¼%	107 —108	108 —107 xd	107	106
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	15½ — 15⅝	15½ — 15⅝	15⅞	15
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	..	6⅜ — 6⅞	6⅜ — 6⅞	..	..
15,000,000‡	Commercial Cable	£100	8 %	8 %	8 %	230 —240	230 —240	..	..
1,932,856‡	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	4 %	4 %	4 %	97 — 99 xd	97 — 99	98⅜	97½
16,000	Cuba Telegraph	10	6¾%	5 %	5 %	8½ — 9	8½ — 9	..	..
6,000	Do. 10 % Pref.	10	10%	10%	10%	17 — 18	16½ — 17½	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	8⅜ — 8⅝xd	8⅜ — 8⅝	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10%	10%	10%	9⅛ — 9 xd	8½ — 9	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	101 —103	101 —103%	..	..
60,710‡	Direct United States Cable	20	3½%	3 %	..	11⅜ — 11⅝	11½ — 11¾ xd	11⅞	11½
78,500	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	141 —144	139 —142 xd	141½	140
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	..	92 — 94	91 — 93 xd	92½	91½
1,836,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	108 —110	108 —110	..	..
900,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14½	14⅜
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	105 —107	105 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	4 %	4 %	4 %	100 —102	100 —102	..	..
300,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	101 —103	101 —103	..	..
160,887	Globe Telegraph and Trust	10	£3 16 7*	5½%	..	10⅜ — 10⅝	10⅜ — 10⅝	10⅜	10⅛
160,887	Do. do. 6 % Pref.	10	6 %	6 %	..	14⅜ — 14⅝	14⅜ — 14⅝	14⅜	14⅛
160,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	37 — 39	37 — 39	40	38
50,600	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
17,000	Indo-European Telegraph	25	10%	10 %	13 %	51 — 53	51 — 53	51¾	..
72,680	Monte Video Telephone Co., Ltd., Ord.	1	3 %	3 %	..	⅜ — ⅞	⅜ — ⅞	..	..
1,988,888	National Telephone, Pref. Stock	100	6 %	6 %	6 %	108½ —109½	108½ —109½	109½	108½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	100 —102	100 —102	101⅛	100
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½ — 13½	12⅝ — 12⅞	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½ — 12½	11¼ — 12⅛	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5½ — 5⅝	5½ — 5⅝	5⅝	..
4,000,000	Do. do. 8½ % Deb. Stock Red.	Stock	8½%	8½%	8½%	100 —102	100 —102	100	..
1,589,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103½ —105½	103½ —105½	104½	104
179,818	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6¼%	6¼%	1⅜ — 1⅝	1⅜ — 1⅝	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	1⅞ — 1⅝	1⅞ — 1⅝	..	..
100,000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	99 —102	99 —102	..	..
11,889‡	Reuter's	8	5 %	5 %	..	7⅞ — 8⅛	8 — 8⅛	..	..
8,237	Submarine Cables Trust	Certs.	6 %	6 %	6 %	125 —128	122 —125 xd	..	..
58,000	United River Plate Telephone	5	7 %	8 %	..	7 — 7⅛	7 — 7⅛	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	..	5 — 5⅛	5 — 5⅛	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	107 —109	107 —109	..	..
15,609‡	West African Telegraph, Shares	10	2 %	4 %	..	8 — 8½	8 — 8½	..	..
80,008	West Coast of America, 1 to 80,000 and 53,001 to 53,008	2½	Nil	Nil	..	⅞ — 1	⅞ — 1	..	..
150,000	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	13½ — 14 xd	13½ — 14	13½	..
76,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	101 —103	101 —103	..	..
563,380	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	101¾	104¾
88,821	West India and Panama Telegraph	10	Nil	Nil	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..
84,568	Do. do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	..	8¼ — 8½	8¼ — 8½	8¼	8⅜
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	..	8 — 8⅜	8 — 8⅜	..	..
80,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,600	100	5 %	5 %	5 %	103 —105	103 —105	101¾	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

43,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	4⅜ — 5⅛	4⅜ — 5⅛	..	..
10,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	4⅜ — 5⅛	4⅜ — 5⅛	..	..
800,000‡	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	91 —103	99 — 103	103	102½
188,301	British Electric Traction	10	8 %	6 %	..	9 — 9½	9⅛ — 9⅜	9⅜	9⅞
156,487	Do. do 6 % Cum. Pref.	10	6 %	6 %	..	10⅜ — 11⅛	10⅜ — 11⅛	11	..
1,000,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	5 %	5 %	5⅔%	120 —122	120 — 122	121½	..
250,000	Do. do. 4½% 2nd Deb. Stock Red.	100	..	..	4½%	98 — 100	98 — 100	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	5⅛ — 6 xd	5⅛ — 6	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	5⅞ — 6	5⅛ — 6	..	..
100,000	Do. do. 4½ % Mort. Deb. Red.	100	4½%	4½%	4½%	101 —104	101 —104	102⅞	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	⅜ — ½	⅜ — ½	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	14/6 to 15/6	14/6 to 15/6	..	..
105,781	Brush Electrical Engineering, Ord., 1 to 105,781	2	Nil	Nil	..	½ — ¾	½ — ¾	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	..	1½ — 2	1½ — 2	..	..
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	92 — 95	92 — 95	..	..
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	79 — 82	79 — 82	..	..
85,000	Callender's Cable Construction shares	5	1s. 6d.	1s. 6d.	..	11 — 11½	11 — 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	5 %	5 %	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
809,000	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	106 —108	107 —109	109	108½
1,963,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	92 — 94	92 — 94	..	..
523,896	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —103	101 —103	..	..
523,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	82 — 85	82 — 85	..	..
1,000,000	City and South London Railway	Stock	3½%	2¾%	2½%	44 — 45	43½ — 44½	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	..	2½ — 2⅝	2 — 2½	2	..
100,000	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	5 %	5 %	5 %	93 — 98	93 — 98	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	1 — 1½	1 — 1½	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	1⅜ — 2½	1⅜ — 2½	..	..
844,028‡	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	80 — 85	80 — 85	..	..
100,000‡	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	84 — 89 xd	85 — 90	85½	85
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	..	1 — 1½	1⅜ — 1½	1⅜	..
81,390	Do. do. 7 % Cum. Pref., 1 to 81,390	2	7 %	7 %	..	2¼ — 2½	2¼ — 2½	2⅜	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	4 %	4 %	4 %	97 — 99	97 — 99	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½ — 10	9⅝ — 10	..	..
900,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	97 — 101 xd	97 — 101	97⅜	97½
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	15 %	15 %	11½ — 12½	11½ — 12½	11⅞	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	5⅝ — 5⅞	5⅝ — 5⅞	5⅞	5½
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	109 —111	109 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10%	..	16 — 17	16 — 17	..	..
800,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	100 —103	103 —103	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	1⅝%	1½%	3⅛ — 3⅜	3⅛ — 3⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	9¼ — 9¾	9¼ — 9¾	..	..
87,250	Telegraph Construction and Maintenance.	12	20 %	20 %	15 %	36 — 38	36 — 38	37½	36½
150,000‡	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	103 —105	103—105	..	..
540,000‡	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	92 — 94	92 — 94	93	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 2½ per cent. (March 9th, 1905).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).— ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years			Closing Quotations April 12th.	Closing Quotations April 17th.	Business done week ended April 17th, 1905.	
		‡	1902.	1903	1904.			Highest	Lowest
£9,377	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	£	8 %	10 %	10 %	9½ — 10½xd	9½ — 10½	..	..
10 623	Do. do. 7 % Cum. Pref. ..	£	7 %	7 %	7 %	9½ — 10½	9½ — 10½	..	..
£88,782	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	105 —108	105 —108	..	..
80,000	Charing Cross and Strand Electricity Supply	£	10 %	8 %	8 %	7⅞ — 8⅛	7⅞ — 8⅛	..	..
80,000	Do. do. 4½% Cum. Pref. ..	£	4½%	4½%	4½%	5⅜ — 5⅝	5⅜ — 5⅝	5 7/16	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	£	4½%	4½%	4½%	5 — 5⅛	5 — 5⅛	..	..
40,000	Do. do. 1903	£	..	4½%	4½%	5 — 5⅛	5 — 5⅛	5 3/16	..
350,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	105 —107	105 —107	..	..
44,486	*Chelsea Electricity Supply, Ord.	£	4½%	5½%	6 %	6½ — 7	6½ — 7	6⅝	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	4½%	4½%	4½%	109 —111	109 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110.595 ..	10	5 %	5 %	6 %	11 — 12	11 — 12	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	13½ — 14	12½ — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid ..	..	5 %	5 %	5 %	123 —127	123 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid ..	100	4½%	4½%	4½%	103 —105	103 —105	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	9 — 9⅛ xd	9 — 9⅛	9⅛	..
80,000	Do. do. do. 6 % Pref., 40,001—80 ..	10	6 %	6 %	6 %	12 — 12¼xd	12 — 12¼	..	..
400,000‡	Do. do. 4½% Deb. Stock	..	4½%	4½%	4½%	110 —113	111 —114	112⅝	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	4½%	4½%	4½%	104 —106	104 —106	105⅛	104⅛
70,000	Edmundson's Electric Corporation, Ord. Shares	£	7 %	7 %	..	6 — 6¼	5⅞ — 6¼	6⅛	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	..	6¼ — 6⅜	6⅛ — 6⅜	6 1/16	6 1/16
800,000‡	Do. do. 4½% 1st Mort. Deb. Stock ..	100	4½%	4½%	4½%	106 —108	106 —108	..	..
21,000	Kensington and Knightsbridge Electric Ord.	£	10 %	12½%	12 %	12 — 13	12 — 18	..	..
136,000	Do. do. do. 4 % Debenture Stock ..	Stock	4 %	4 %	4 %	101 —103 xd	101 —103	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	2½ — 3⅜	2½ — 2⅝	..	..
69,000	Do. do. do. 6 % Pref.	£	6 %	6 %	6 %	5½ — 5⅝	5½ — 5⅝	..	..
371,895	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	4 %	4 %	4 %	99 —101	99 —101	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	7½%	8½%	10 %	17½ — 18½xd	17½ — 18½	18⅛	17⅝
76,121	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	£	4½%	4½%	4½%	6⅝ — 6⅞	5⅝ — 6⅞	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	4½%	4½%	4½%	109 —114	109 —114	..	..
450,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	3½%	3½%	3½%	97 — 99	97 — 99	99⅞	99½
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	99 —101	99 —101	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½ — 15½	14½ — 15½	..	..
59,000	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	100 —102 xd	100 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£	14¾%	14¾%	14½%	13½ — 14½	13⅝ — 14½	14⅜	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	£	7 %	7%	7 %	8½ — 8⅝	8½ — 8⅝	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	3½%	3½%	3½%	98 —100	98 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£	3⅛%	4 %	4 %	2⅝ — 3⅛	2⅝ — 3⅛	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	79 — 83	79 — 83	..	..
65,000	South London Electricity Supply, Ord.	£	13⅛%	3 %	4 %	3½ — 4½	3½ — 4½	..	..
100,000	South Metropolitan Electric Light and Power Ord.	£	Nil	Nil	Nil	¼ — 1	¼ — 1	..	..
50,000	(*Late Blackheath and Greenwich* 7 % Pref.	£	Nil	7 %	7 %	1⅜ — 1⅝	1⅜ — 1⅜	..	..
100,000	*Dist. E.L.Co.*) 4½% 1st Deb. Stock	100	4½%	4½%	4½%	105 —108 xd	105 —108	..	..
80,000	Urban Electric Supply, Ord.	£	5 %	5 %	5 %	4 13/16 — 5 1/16 xd	4 13/16 — 5 1/16	..	..
80,000	Do. do. 5 % Cum. Pref.	£	5 %	5 %	5 %	5 — 5⅛ xd	5 — 5⅛	5⅛	5⅛
200,000	Do. do. 4½% 1st Mort. Deb. Stock Red ..	100	..	..	4½%	104 —106	104 —106	..	..
110,000	Westminster Electric Supply, Ord.	£	12 %	18½%	14%	12 — 13	12⅜ — 13⅛	13	12½
28,151	Do. do. 5 % Cum. Pref.	£	5 %	5 %	5 %	6 — 6½	6 — 6½	..	..

Shares not officially quoted :—Mackay Companies, ord., 43—43½. Pref. 76—76½.

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Monday, April 17th.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	82/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£38 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£5 5	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£18	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£22	£1 dec.
a Lead, Nitrate	per ton	£25	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2,6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	8d.	..
a Potash, Caustic (75/80%)	per ton	£22	£3 inc.
a Potassium Cyanide	per lb.	7½d.	..
a Shellac	per cwt.	165/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 16	..
a ,, Crystals	per ton	£8	..
Sodium Bichromate, casks ..	per lb.	9½d.	..
,, Cyanide	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£180	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
b Babbitt's metal ingots	per ton	£48 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	..
c ,, Tube (brazed) .. .	per lb.	9¾d.	..
c ,, ,, (solid drawn) ..	per lb.	9d.	..
c ,, Wire, basis	per lb.	8d.	..
c Copper Tubes (brazed)	per lb.	10½d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	..
g Copper Bars (best selected ..	per ton	£82	..

METALS, &c. (*continued*).		Latest Price.	Fortnight's Dec. or Inc.
g Copper Sheet	per ton	£82	..
g ,, Rod	per ton	£82	..
e ,, (Electrolytic) Bars ..	per ton	£70 10	..
e ,, Sheets ..	per ton	£87	..
e ,, ,, Rod ..	per ton	£81	..
e ,, ,, H.C. Wire	per lb.	9⅜d.	..
f Ebonite Rod	per lb.	3/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/6½ to 5/7	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	70/-	1/- inc.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£13 2 6 to £13 5	7/6 inc.
g ,, ,, Sheet	per ton	£14 10	5/- inc.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 7 6	5/- dec.
d Mica (in original cases) small ..	per lb.	6d. to 1/	..
d ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, large ..	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/3	..
p ,, ,, strip & sheet	per lb.	1/3	..
o Platinum	per oz.	£2/6	..
e Silicium Bronze Wire	per lb.	10½d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£68	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£138 to £139	20/- to 40/- inc.
n ,, Wire, Nos. 1 to 16	per lb.	1/7½	..
p White Anti-friction Metals:—			
"White Ant" brand ..	per ton	£43 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 les. Flax	per lb.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 13/16d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't's (Vieille Montagne bnd.)	per ton	£26 17 6	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co., *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

Trade Marks in Egypt.—Messrs. W. P. Thompson and Co., 6, Lord Street, Liverpool, write us as follows:—"We have received word from our agents in the Egyptian Sudan, that that country is being simply deluged with cheap Continental goods marked with English trade marks; that the Custom House is desirous of stopping this trade, but cannot do so, as the English manufacturers have very few of them registered their trade marks, but that they will at once stop such fraudulent importations of any registered trade mark, on the marks being put on the register. The German manufacturers have been very much more wide-awake than the English in this respect. The Associated Brewers of Pilsen registered their marks and then got the Government to at once stop all beer imported into Egypt and the Sudan with the word Pilsen or any of their marks on it, unless shipped by them, and the Munich brewers have lately done the same as regards Munchen and Munich. Some little time ago our agents discovered a printing works in Egypt engaged almost exclusively in printing fraudulent labels, which were sent on goods not merely all over Egypt, but to Singapore, Hong-Kong and elsewhere in the East. This place was broken up through our agency by getting the rightful owners of these labels to register, and then pouncing on it."

Gas.—A man, aged 62, residing at Wandsworth, died from the effects of coal gas poisoning last week, owing to gas having escaped from an old-fashioned chandelier to which incandescent gas fittings had been affixed. The chandelier had slipped down and there was no water in the container. The jury added to their verdict, a rider warning people of the danger of overweighting old fittings with incandescent gas burners.

INSTITUTION OF ELECTRICAL ENGINEERS.

HEATING AND SPARKING LIMITS IN VARIABLE SPEED MOTORS.

By A. H. Bate.

(*Abstract of Paper read at Birmingham on March* 15th, 1905.)

In this country the "individual drive" is comparatively little used; in America, however, the case is different. There the advantages of electrical power are more generally recognised by manufacturers, and, owing to the greater cost of labour, a reduction in the time taken for each operation has more influence on the cost of production than is the case in this country.

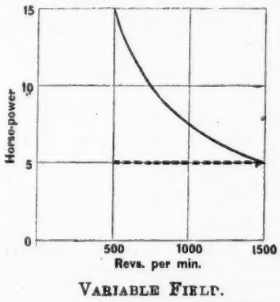
The introduction of the high-speed tool steels has so increased the power required by many machines that in the case of some of the larger tools a variable speed motor is almost a necessity, if the work is to be done to the best advantage. Take for example the case of a 16-in. roughing lathe. Four years ago such a tool would have taken about 5 H.P. from the shafting, while now it requires 30 to 40 H.P. By the use of variable speed motors the labour cost in certain classes of work may be reduced by 20 per cent., and sometimes even by 40 per cent.

Broadly speaking, there are three ways of varying the speed of a shunt motor:—

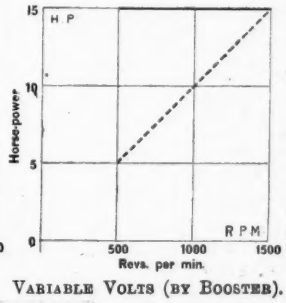
1. Varying the magnetic flux through the armature.
2. Varying the pressure applied to the armature.
3. Changing the number of turns on the armature, by providing two commutators and two sets of windings connected in series or in parallel.

Each of these methods has characteristic features that fit it for particular purposes. We will first consider the factors that determine the sparking limits.

In the short interval of time that the coil is short-circuited under the brush, the current in the coil has to be reduced to zero, and brought up to its full strength in the opposite direction. If the brush width w is equal to q, the width of one segment plus mica, the full current of the motor $= 2c$ will pass from the brush into this segment when they coincide. An E.M.F. e is required to overcome



Variable Field.



Variable Volts (by Booster).

the contact resistance between brush and segment, and an E.M.F. E is required to force the current c through the resistance of the coil itself. Neglecting the self-induction effect for a moment, when the commutator moves forward the resistance of contact will be increased, and as the current c is proportionally reduced, the value of e remains unchanged. The value of E has no bearing on the problem of commutation.

We will now consider the dissipation of the energy stored in the coil due to self induction, assuming that the brushes are so placed that the stray magnetic field generates no E.M.F. in the coil. We will write F_s for the E.M.F. generated by reversing the total linkage through the coil in time t. While the coil is short-circuited this E.M.F. sends a current that passes from one segment into the brush and from the brush to the other segment and round the coil. In passing from segment to brush and brush to segment this current is opposed by the E.M.F.'s e_1 and e_2, due to the resistances of contact between the brush and the respective segments. When the brush is just coming into contact with and when it is just leaving a segment, the sum of these resistances is very high, and when the brush bears equally on each segment it is a minimum. The E.M.F. e due to the main current passing through these resistances need not be considered, because at one segment it opposes, and at the other segment it assists the short-circuit current. If the contact resistances between brush and segment are to be solely relied on to absorb the electro-magnetic energy stored in the coil, the average value of the E.M.F. due to the short-circuit current passing through these resistances must be equal and opposite to the average value of the reactance voltage E_s.

In modern dynamos and motors the contact resistance does effect the commutation satisfactorily, even when the stray flux is opposing and not assisting the reversal of the current. As the contact resistance of the brushes can only be varied within narrow limits, it is necessary to so reduce the self-induction of the coil that the value of the F_s is not too great. Mr. Hobart has described a series of tests on the inductance of armature coils under various conditions. For the part of the coil embedded in the slot, and with a slot three times as deep as it is wide, his results show that there are about 10 lines of force per ampere-turn per inch of effective length of core l_s, and a corresponding number of about two lines per inch for the part of the coil outside the slot l_a. Calling these values respectively f_s and f_a, we have—

Self-induction of one turn of the coil $= f_s l_s + f_a l_a$

and Mutual induction $= (f_s l_s + f_a l_a) m_1 m_2 \frac{p}{b}$,

where m_1 is the turns per segment, m_2 the turns of all coils simultaneously undergoing commutation, p the number of poles, and b the number of circuits in the armature.

Multiplying by the maximum current in the coil, we get—

$$\text{Total linkage} = (f_s l_s + f_a l_a) m_1 m_2 \frac{p}{b} c.$$

As t, the time in seconds occupied for commutation, stands for the time of half a cycle, the periodicity is $\frac{1}{2t}$ cycles per second, and assuming the sine law, for want of better, the E.M.F. induced in the coil by reversing the above linkage—that is to say, the reactance voltage—is

$$E_s = (f_s l_s + f_a l_a) m_1 m_2 \frac{p}{b} c \times \frac{2\pi}{2t}.$$

If w = the width of brush, q the width of segment, s the number of segments, n the r.p.m., we have $t = \frac{60\,w}{s\,q\,n}$. Then, as $m_2 = m_1 \frac{2\,w}{q}$ the values of w and q cancel, and we have—

$$F_s = 0{\cdot}1046\ (f_s l_s + f_a l_a)\ m_1^2 \frac{n}{b} c s n \times 10^{-8}.$$

The R.M.S. value of the reactance voltage would be $\frac{E_s}{\sqrt{2}}$ if the change followed a sine law. If the stray field is inducing an E.M.F. E_m in the coil while commutation is taking place, to obtain perfect commutation we must have—

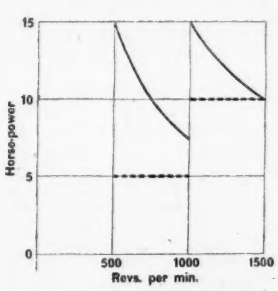
$$\frac{E_s}{\sqrt{2}} \pm E_m = e_1 + e_2.$$

In practice the reactance voltage calculated from the above formula gives a surer indication of the current and speed at which sparking will commence than any other criterion that has been advanced so far, but it is not an infallible guide in all cases. Tests of small bipolar motors give very uniform results even with extreme variations in the speed and power of the machine, but for some reason the reactance voltage at which a multipolar motor will commence sparking is not so constant.

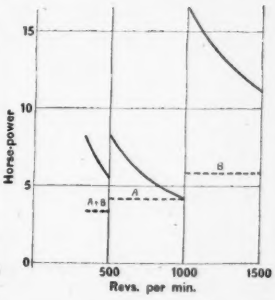
When, however, the reactance voltage is used as an indication of the current at which any one motor will commence to spark when the speed is varied by altering the terminal pressure or by varying the field strength, it gives remarkably consistent results.

Assuming, then, that reactance voltage may be taken as a safe guide for studying variable-speed motors, we will proceed to notice its effect on the horse-power that can be taken with different methods of speed control. For purposes of comparison we will take a motor which, if wound for constant speed, would give 10 H.P. at 1,000 r.p.m. The armature windings and commutator segments are supposed to be so proportioned in each case that the sparking and heating limits coincide at the speed for which the commutation is poorest. It will be sufficiently correct for our purposes to take the core losses as being proportional to the product of speed and flux density in the armature core. For the sake of simplicity we will neglect the change in efficiency as the load varies and also the improved ventilation of the armature that is obtained with higher speeds, and take the heating limit as being conditioned by C^2R loss alone. The correction for these quantities depends on the construction of the particular type of motor concerned, and does not seriously affect the result.

The accompanying curves show the horse-power of such a motor as limited by heating and sparking. The dotted lines represent



Multiple Mains (Three-Wires); also Double-Wound Armature, 1 : 1.



Double-Wound Armature, 2 : 1.

the horse-power as determined by heating limits, and the full lines the overload that can be taken for short periods without causing sparking.

Attention may be drawn to the last arrangement given. The speed range is greater than is obtained by a double-wound armature with equal windings, and as there are three possible combinations instead of only two, the intervals in the speed that have to be filled in by field regulation are not so wide. The power available from heating considerations is certainly less than it would be if equal windings were used, but this would not be a serious drawback for many purposes where the load is intermittent. There is one weakness, however, namely, that the commutation is poorest

at a middle speed instead of at the highest speed. It certainly seems that this arrangement deserves more attention than has been given to it.

When selecting the method of obtaining variable speed, it is necessary to take the load factor into consideration. To illustrate the importance of this point, we will compare the duty imposed on the motor by a lathe, a ram pump and a planing machine.

In the case of the lathe, approximately the same power will be required at all speeds, but as there are usually considerable intervals of rest and light load in this class of work, the heating limits need hardly be taken into account. What is wanted is a motor that can deal with the same overload throughout its speed range. For this the regulation by a reversible booster would be the ideal method if the cost were not prohibitive. The multiple mains system meets the case fairly well, but the cost of extra cables and switchgear is only repaid when a fairly large proportion of the motors are required to work at variable speeds. One has, therefore, to fall back on regulation by varying the field, and this gives excellent results in practice in spite of the restricted overload capacity at high speeds. If the motor is liberally rated, overloads that cause sparking will not be frequent or of long duration in most cases, and the brushes polish the commutator during the subsequent working at light loads.

In the case of the ram pump the load is likely to be continuous, and heating limits are therefore of more importance than considerations of sparking. As the power required by the pump increases with the speed, the double-wound armature with equal windings is obviously best for this purpose, unless a multiple mains system is available.

The driving of a planing machine by a motor presents a more difficult problem. The load may be almost continuous, and at each reversal there is a very heavy overload for an instant. Mr. A. D. Williamson has, I believe, been successful in using the shunt-wound motor with variable field control for this purpose. The resistance in series with the field spools is short-circuited by a switch (operated by the movement of the table) during the time of reversal. The speed of the motor is thus reduced and the sparking limits proportionately increased just when the overload is being dealt with.

Mr. H. M. Hobart, in a written communication, stated that the design of a motor for variable speed by shunt control was, in reality, the simplest case with which a designer had to deal. This was for the reason that, if the speed range was to be at all great, it was useless to set the brushes with a fixed angular displacement from the neutral position for the purpose of thereby assisting the commutation. The extreme case was met in the motor which must run in either direction. It was the writer's practice in such a case to design the motor with the brushes at the geometrical neutral point, and with a sufficiently low reactance voltage to preclude sparking at the highest speed required for a given load. Mr. Bate's tests had also shown that in such a case the current at which sparking commenced was inversely proportional to the speed, and that this was so even in the extreme case of unexcited fields, the armature being driven by motor. This case was met with in continuous current potential regulators, which were coming into more and more extensive use to displace rheostatic control of large motors. Returning to the motor for operation at varying speed by shunt control, it would be well to point out that it was preferable to choose as low a maximum speed as possible. That was to say, if it was required to drive a machine tool with a maximum speed of 100 r.p.m. and a minimum speed of 25 r.p.m., it would be well to choose a very low gear ratio, letting, for instance, if 10 h.p. was required, the corresponding speeds of the driving motor be 400 r.p.m. and 100 r.p.m., rather than, say 1,000 and 250 r.p.m. This would be the more important the higher the voltage of the network. Thus for a 440-volt system, it would be highly important to adopt the lower speeds, whereas for a 110-volt system, the higher speeds would give a good result. For 220 volts, the lower speeds would, on the whole, be preferable. In a contribution to the Electrical Review for December 4th, 1903 (p. 926) he had endeavoured to give a rough idea of this matter.

Mr. C. W. Hill, in a written communication, said that in addition to the methods mentioned by Mr. Bate for controlling the speed of motors, there was one tried some years ago which did not appear to have attracted much attention. The method was devised by a Mr. S. N. Rushmore in 1897, and although not intended specially for motor controlling, it would appear suitable for that purpose. (Details of his experiments were given in the *American Electrician*, and there was also an article in the Electrical Review of April 14th, 1899.) Mr. Rushmore's method consisted in using multipolar dynamos having parallel-wound armatures in which the brushes, instead of being connected to feed a single circuit, were connected independently to separate circuits, the voltage and current in each of which might be varied without reference to the others. The machine on which the experiments were made was a four-pole machine feeding two separate circuits. It was shunt-wound, the magnet coils being in two circuits corresponding to their respective pairs of brushes with regulating resistances for varying the voltage. With such an arrangement a development of the Ward-Leonard system seemed possible. A single motor-generator set would be capable of serving several motors instead of only one, and each motor could be started, stopped and regulated independently of the others. As an instance of the possible application of this method they might take the case of a couple of air compressors supplied with current from a four-pole generator. In such a case, by connecting the compressor motors on separate circuits, the speed of each might be economically regulated over a wide range, and the starting arrangements would be simple.

With regard to shunt motors in which the speed was regulated by varying the field, he had for about two years been using this type of motor for a purpose for which, at first sight, it would hardly seem suitable—namely, for the hoisting gear of cranes. Where a hoisting gear was in an inaccessible position, as in the case of the crab on an overhead crane, the series-motor had drawbacks. To a certain extent it varied its speed according to the load, but as this extent was limited, it was usual to fit speed change-gear on the crab so as to increase the speed range. To change the gear it was, however, necessary to run the crab up to the cage, and in some cases it was also necessary for the driver to get up on to the platform. This involved so much trouble that the change gear was seldom altered, and might in most cases be as well left off. If they used a shunt motor, the speed changes could be instantly effected without trouble by means of a shunt-regulating switch placed in the cage. In order to prevent the load from running away when lowering with a series motor, an automatic mechanical brake was necessary which came on when the load overhauled the motor. This was not required with a shunt motor, as the latter, when overhauled by the load, returned current to the circuit, and so automatically offered the right amount of resistance to keep the speed of lowering within the required limits. On a 30-ton crane to which he had fitted a shunt-motor, the speed of lift could be varied from 4½ ft. per minute for a full load to 19 ft. per minute for the hook only. When lowering, with the regulating switch on the same positions the speed was a little greater than when hoisting. These were the speeds when the controller was full on, lower speeds being obtained on the intermediate steps. Thus when lowering 30 tons, the speed on the first step was 9 in. per minute, and when full on the speed was 5 ft. per minute, and at this speed the motor returned 20 amperes to the circuit, the voltage of which was 220. The 30-ton crane was the first to which he had applied a shunt motor. It had worked very satisfactorily for nearly two years, and the same arrangement had since been fitted to several other cranes.

Mr. Holden asked if Mr. Bate had used reversing poles on motors in order to increase the sparking limit. Personally, he had used them to great advantage in the case of a 70-h.p. motor, which was started up light, run for a few seconds heavily loaded, and then stopped and reversed. Carbon brushes were used, placed in a central position. He advocated the use of series motors in many cases where machines were driven by a separate motor. They were specially suitable in the case of planing machines, as they gave a powerful torque at reversal, and were capable of taking a very heavy overload.

Mr. Bate, in his reply, said that he was much interested in Mr. Hill's description of the use of shunt motors for cranes. He thought it one of the many purposes to which variable speed shunt motors might be applied. But he doubted if the average crane driver would take the trouble to vary the field rheostat. He had never worked with reversing poles, having regarded them as unnecessary for ordinary working, since good results could be obtained by the shunt rheostat with low reactance voltage and carbon brushes. He appreciated the suitability of series motors for driving planing machines. When using a shunt motor for this work it was important to get a fly-wheel effect, and to make the commutating conditions very good.

POWER GAS.

On March 16th a paper was read before the Leeds Local Section by Dr. F. H. Bowman, dealing mainly with the use of suction gas plant for central station working. The paper would have been the better for sub-editing, as the style is not above criticism; and much of the matter is of a very elementary character.

The author considers that pressure gas producers, using bituminous fuel, ought not to be employed in connection with installations of less than 1,000 b.h.p. With plant of this size, using bituminous fuel and recovering the residuals, "a b.h.p. can be produced at a cost of under 0·2d. per hour, including everything." This statement, however, must presumably be taken to exclude capital charges. With Dowson plant using anthracite or coke, "a b.h.p. may be obtained, including everything, for about 0·45d. per hour."

The author then proceeds to describe the "Dynamic Gas Producer," which he considers "the most perfect of its type." Referring to the chief drawback of the suction gas producer, in that it cannot be run on light load for long, he states that the limit of continuous satisfactory running is about one-fifth of the normal full load. No advantage is claimed for gas plant where the generating sets are above 2,000 b.h.p., but it is stated that with small units of 100 to 500 b.h.p. as great economy can be obtained as with the largest steam or water-power plants running under the most favourable conditions. The saving effected by using suction gas plant, as compared with town illuminating gas, varies from 50 per cent. with town gas at 1s. 4d. per 1,000 cb. ft. to 84 per cent. with gas at 4s. (these figures referring to fuel cost alone).

The result of a trial carried out at the works of the makers of the Dynamic Gas Producer with an engine giving 11·5 b.h.p. was a consumption of 0·835 lb. of anthracite per b.h.p.-hour, costing, at 32s. per ton, ¼d. per b.h.p.-hour. Allowing for the cost of the producer £110, and for the engine, £105, the cost of running for 10 hours daily is worked out at 0·51d. per b.h.p.-hour; this estimate includes one-quarter time of an attendant at 25s. per week, allowance for rent, rates and taxes, and interest and depreciation at 10 per cent. per annum. Allowing for the cost of a dynamo, the author brings the cost per b.h.p-hour up to 0·563d., and then says, "Adding one-fourth to this, we get the cost

per B.T.U. per hour = 0·704d. per hour, which is a little less than ¾d. per B.T.U." Apart from the fact that elsewhere in his paper he uses B.T.U. to represent British thermal units (which should be B.Th.U.), we must point out that adding one-fourth to the cost per H.P. does not give the cost per KW. One-third must be added at least, and if allowance is made for loss in the dynamo, the addition must be increased to one-half. As this error occurs elsewhere in the paper our faith in the author's figures is rudely shaken.

Mr. BOWMAN goes on to discuss the working of a plant of 500 I.H.P. The steam plant costs in all £7,200, and working at 80 per cent. full load for 3,000 hours per annum gives a result of 0·51d. per B.T.U. The equivalent gas plant costs £6,300, and under the like conditions works at 0·44d. per KW.-hour. Unfortunately, these figures appear to be purely hypothetical. The economy and usefulness of the suction gas producer and engine for small electrical installations have already been demonstrated beyond question, and little good can be done by advancing arguments so poorly substantiated as those in this paper. What we want is the working results.

ST. LOUIS INTERNATIONAL CONGRESS.

REPORT ON ELECTRICAL UNITS.

AT the meeting held on April 6th, Mr. W. DUDDELL opened the discussion upon the section of the report of the International Congress at St. Louis, dealing with the legalised standards of resistance, current and E.M.F., and the names to be adopted for the C.G.S. magnetic units; the discussion on the section having reference to alternate current motors for traction, being deferred to a later meeting of the Institution. Mr. DUDDELL propounded a series of questions as being those upon which discussion might take place most profitably. The gist of these questions was:—What is the true value of the volt and ampere? And he pointed out that it is now generally admitted that 1·433 volt is the correct value of the E.M.F. of the Clark cell as prepared in accordance with the Board of Trade Order in Council, instead of the legal value of 1·434: he was of opinion that we must accept the mercury standard ohm as being correct from the fact that a mercury standard ohm prepared by the National Physical Laboratory agrees with that prepared by the Reichsanstalt, and for the unit of current, Mr. Duddell asked whether we should depend upon the standard silver voltameter, or upon the ampere balance.

The next question was, Should the legally defined unit be defined by the C.G.S. units? In this connection he said that we really need the C.G.S. units or multiples of them as primary standards, then a concrete representation of these primary standards as secondary standards, and, finally, a tertiary or workshop standard; the essential qualities of the secondary standards must be permanence, and reproducibility, and of the tertiary standards, moderate accuracy, ease of use, and setting up, and of checking against the standards of the National Physical Laboratory.

As a good example of a secondary standard Mr. DUDDELL cited the mercury ohm, but he doubted whether it would be used as a workshop standard.

With reference to the magnetic units, names are required for the units of magnetomotive force, magnetic flux, and magnetic reluctance, and Mr. Duddell concluded by asking whether the 4π should be moved, and whether the C.G.S. units of these quantities need names.

Mr. ROBERT KAYE GRAY then remarked upon the somewhat tardy decision of the British Government to send representatives to the St. Louis Congress, and told how the opinions of the representatives of the Institution, and of the British Government, carried great weight in the decisions arrived at.

Lord RAYLEIGH thought that the value of the ohm appeared to have been accepted as correct too readily; he agreed that the ohm should be taken as the first principal standard, and was of the opinion that the ampere, rather than the volt, should be the second principal standard, as the errors and corrections of the ohm would then have no bearing upon the errors and corrections of the ampere. As to whether the Clark or Weston cell should be adopted as the standard cell, the great advantage of the latter cell, with its very small temperature coefficient, pointed to the desirability of adopting it as the standard cell, but at present he thought we knew too little of it to set it up in place of the Clark cell.

Prof. W. E. AYRTON was of opinion that the St. Louis Congress had made a mistake in discussing the vagaries of the electrolytic measurement of current, and the potential difference of a cell, instead of discussing the accuracy of value of the ohm; there was a considerable difference in the leading English determinations of the ohm, and Prof. Ayrton on reading the discussion at St. Louis thought, from the manner in which the value of the ohm was taken for granted, that there must have been some later and more accordant determinations with which he was unacquainted, but such was not the case.

In reference to the work done by Prof CARHART upon the determination of the ampere in terms of the standard cell and ohm, he considered that Prof. Carhart had made a fundamental mistake in employing the apparatus he did, involving the rather obscure effects of elastic fatigue, whereas a piece of apparatus made on the lines of the chemical balance, which had now been brought to such a point of accuracy, would have given better results; the fact that the mercury ohms prepared by the National Physical Laboratory and the Reichsanstalt agreed exactly proved merely that two mercury resistances could be prepared per specification to agree to one part in 100,000 and proved nothing about knowing the ohm.

The Drapers' Co. were giving £700 for a new and improved Lorenz apparatus from which he hoped to see a far more correct value of the ohm obtained; he thought the first principal standard should be the ohm, and the second the ampere, because the volt was difficult to determine in electro-magnetic, though easy in electrostatic measure, but the transformation demanded a knowledge of v, at present a none too well-known quantity.

The speaker then described a piece of apparatus recently completed for the absolute determination of the ampere, working on the principle of a very highly sensitive chemical balance. Suspended from each end of the beam is a coil with a single layer of wire, so as to form a current sheet, the currents in these two coils being in the same direction. Each coil is internal and concentric to a stationary coil fitted with suitable adjusting screws; the currents in these coils are in opposite directions.

From the value obtained for the attraction or repulsion between these coils, and the data of the coils, they could determine the ampere absolutely.

The insulation resistance of the winding of these stationary coils, which consisted of a single layer in alternate spirals upon a marble core, was extremely high. Very shortly Prof. Ayrton hoped to have determined, with this apparatus, the accurate value of the ampere.

Mr. A. P. TROTTER, speaking quite unofficially, emphasised the distinction between units and standards, and the fact that the British Weights and Measures Act demanded standards; and he drew attention to the wording of the Orders in Council, in which the various units are said "to be represented by," whereas other Governments say "substantially equal to."

The mercury standard ohm, and the silver voltameter, Mr. Trotter thought were amply good enough for trade, and when the redeterminations of the ohm and ampere were completed, the B. of T. might declare an official correction.

He was of opinion that the known error in the value of the Clark standard cell was not of appreciable commercial importance, except perhaps in the testing of lamps; but the specification of the Clark cell was certainly out of date, and he preferred the saturated cadmium cell to the semi-saturated cadmium cell, though the temperature coefficient was higher in the former case. He leant more towards the adoption of the multicellular voltmeter, in place of the Clark cell.

Mr. F. E. SMITH dealt somewhat at length with the accuracy to which the standard ohm, volt and ampere could be realised, and with the permanence of these standards; he thought that if the Clark cell were kept at the temperature of melting ice, the results obtained would show the cell to be equally as good as the cadmium cell, about the permanence of which they knew very little, and he believed the time was not far distant when the testing rooms of large manufactories would be found equipped with the mercury ohm.

At the adjourned discussion on 13th inst, Dr. R. T. GLAZEBROOK, referring to the discussion at St. Louis, said they were not dealing so much with absolute units, or considering whether the C.G.S. units were the best obtainable, but were endeavouring to settle a satisfactory reproducible unit to be used throughout the world. It was not necessary to discuss the ohm or the value of mercury, because it had proved satisfactory in practice, and the volt and ampere only remained to be dealt with. He quite agreed with Mr. Trotter in regard to the English standards; the latter were defined by schedules, and had nothing to do with the units now under consideration. They were, to a certain extent, independent of the exact definition, but were verified from time to time. The trouble arose from the various standards in use in different countries not being as nearly identical as was possible, and the object of the conference which it was proposed to hold, and to which the British, French, German and Italian Governments had agreed, was to establish a universal standard.

Prof. S. P. THOMPSON urged that it was only necessary to fix one unit, as that in itself would settle the other two. It was necessary to exercise great care in setting up standards, and he reminded his hearers of the past history of the subject, and the discrepancies which occurred when these were verified from time to time. He considered that one must stick to the standard and scrap the unit. If the watt and ohm were settled, they must make the volt and ampere come where they would. The Professor referred at length to Prof. Ascoli's exposition of M. Georgi's system of units, which the speaker considered to be ideal, and he concluded by expressing the hope that we should not be saddled with any new standard.

Col. R. E. CROMPTON said it was no use having standards which were not applicable in the shops. He had tried to obtain standards which could be carried about, and thought the tertiary standards were matters of importance and should be accurate. They had succeeded in getting fairly accurate standards of voltage and resistance, and he considered that they must adhere to the watt and ohm.

Mr. H. ERAT HARRISON considered that there would be considerable difficulty in adopting Prof. Ascoli's proposal, and that they must have ideal units and standards as far as possible in agreement. If they made their standards their units, they would be taking a backward step; the discrepancies between the various national units were insufficient to make any practical difference to the user, as also would be any slight future changes.

The last speaker, Mr. CRAWLEY, urged that we should stick to the standard, right or wrong, and the President intimated that certain members had decided to communicate their remarks to the Journal.

Radium and Cancer.—It is stated that the annual report of the Hospital for Diseases of the Skin places on record a satisfactory cure of cancer by means of radium.

TESTING OF DIRECT-CONNECTED GENERATORS.

An article by G. T. Hanchett in the *Electrical World and Engineer* of March 4th, gives a useful account of the commercial testing of dynamos, of which the following is a condensation. The points of view of the manufacturer and buyer of a dynamo as regards its performance, differ inasmuch as the manufacturer wishes to separate the losses of the machine in order to build a better, while the user is only desirous of limiting the total loss, of ensuring that no part of his machine is injured by too great a concentration of loss therein, and of satisfying himself as to the proper regulation of the machine on load. The usual test is to run the machine loaded, taking certain electrical and thermal measurements. Previous to this the resistance of the field coils and armature are taken at the engine-room temperature by the fall of potential method, using an accurately graded ammeter and millivoltmeter. The machine is next run at full potential and speed on open circuit to adjust the brushes, examine the bearings and warm up the field coils. Load is then applied by means of water or other resistance to the full load capacity of the set for about two hours.

Any lead given to the brushes to secure sparkless commutation must be noted and marked on the rocker. The regulation of the machine is now tested by adjusting the field resistance to give the proper machine E.M.F. at full load (the resistance coils being normally warm), the speed and E.M.F. very carefully noted, and the load suddenly thrown off. Reducing the engine speed to normal as quickly as possible by the steam admission and drains, the machine E.M.F. should be again noted. If the speed cannot be exactly adjusted, it should be noted, and the observed voltage corrected by dividing by this speed and multiplied by the rated value. The result should be the no-load voltage at which the dynamo is rated.

On opening out the steam admission, closing the drains, and throwing full load on again, the voltmeter should show full load voltage once more, as soon as the engine has regained its normal speed. This may not be strictly the case, owing to the hysteresis of the iron in the field, but the "history" of the iron should not affect the reading by more than 1 per cent. After the guaranteed number of hours of run, the resistance tests should be repeated, and recorded as the hot resistance of the machine. Thermometers are placed, one on the armature surface, covered with a pad of waste, another on the commutator, similarly covered, and a third in the field coils. The values will first rise, then fall, the machine becoming hotter after remaining at rest for a short time, because the outer surfaces which were cooled by windage during running, are now heated up from the inside. These may be checked by the resistances with the approximate formula $R_H = R_C [1 + \cdot 004 (T_H - T_C)]$, when R_H, R_C are the resistances hot and cold respectively, T_H, T_C the final and initial temperatures, Centigrade. The value obtained electrically is usually higher and more accurate than that found thermally, as it measures the internal heat. The American Institute of Electrical Engineers prescribes a normally rated machine as having a rise of 50° C. in field and armature by the resistance method, and 55° C. in the commutator and brushes by thermometer. The insulation resistance, hot, of the machine, is found by putting it in series with a voltmeter of known resistance across a known voltage, and noting the voltage drop across the machine insulation. For a 220-volt machine the minimum resistance should be 1 megohm. If less, disconnect the various parts of the machine till the leak disappears. If the leakage is general, and in the rough proportion of two-thirds in the armature to one-third in the field, it is probably due to dampness, and will eventually disappear. A local leak of any magnitude in the rocker or terminal block should be remedied at once, as it may grow.

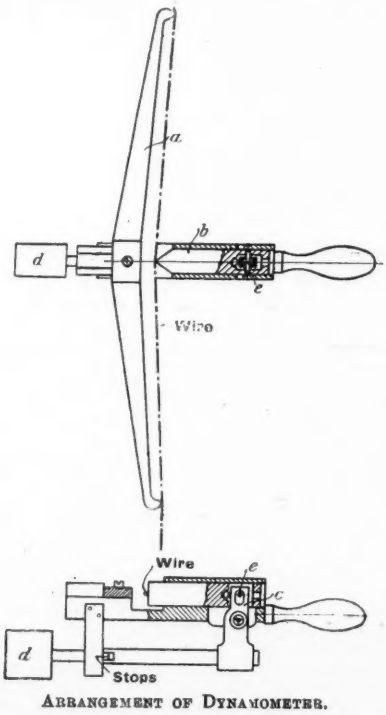
The commercial efficiency, though capable of being roughly tested by indicating the engine simultaneously with measuring the output, is best performed by the stray power method. Immediately after a previous run on load the armature is driven as a motor on no load from an external electrical supply, the engine connecting rods being disconnected from the crankshaft. The field excitation and the measured armature current are varied until rated speed is reached at rated armature pressure (back E.M.F.). The series coil, if present, must be omitted, the current passing directly to the armature. Note the speed, the voltage impressed on the armature, the current passing through it, the hot resistance of the armature and series coils, and the hot resistance of shunt field circuit including the part of the rheostat used. Since the dynamo losses comprise those in the bearings, in brush friction and windage, hysteresis, eddy currents, copper losses in the armature and series circuits, and copper losses in the fields, the method is to calculate these separately. The copper (C^2R) losses are calculable from the measurements of hot resistance, currents flowing, and E.M.F.'s impressed. The article includes a typical efficiency calculation, of which the following is the generalised statement:—If speed as motor = s, impressed E.M.F. on armature = v, current used in driving the armature = c, hot resistance of armature = r_a, hot resistance of series field coil = r_s, hot resistance of shunt circuit = r_f, then watts applied to armature = $c\,v$. Armature copper losses = $c^2 r_a$, and stray power of the armature (hysteresis, eddy currents, windage) = $c\,v - c^2 r_a = p$. The voltage drop in the armature = $c\,r_a$, and back E.M.F. developed by the armature = $v - c\,r_a$. If now the machine terminal voltage at any desired load of C amperes is V when running at speed S, and c_s = shunt current, the armature circuit drop when running as a dynamo is $(C + c_s)(r_a + r_s) = v_a$, and the total armature voltage is $V + v_a$. The stray power of the armature when running as a dynamo is then $\frac{p\,S\,(V + v_a)}{s\,(v - c\,r_a}} = P$. The copper loss in the armature is $(C + c_s)^2 \cdot r_a$; that in the series coil $(C + c_s)^2 r_s$; that in shunt coil = $V c_s$. The addition of these last four losses give the total loss at the given load = T. The output is $V C$, the input $V C + T$, the efficiency $\frac{V C}{V C + T} \cdot 100$ per cent. The friction of the engine bearings is included in the above method. The hysteresis loss is proportional to the speed and the 1·6th power of the armature voltage, while the eddy current losses are proportional to the square of the armature voltage and the square of the speed, whereas in the test these are assumed proportional to the speed. With care in measurement, however, the error so produced is under 1 per cent.

A DYNAMOMETER FOR MEASURING THE TENSION IN OVERHEAD LINES AFTER ERECTION.*

Overhead telegraph wires have to be subjected to considerable tension when being erected in order to prevent the vibrations produced by the wind, from causing accidental contact between different wires. The tension on the wire depends on the dip, and the latter is itself dependent on the length of span, on the coefficient of elasticity, and on the temperature coefficient of the wire.

In order, therefore, that the tension to which the wire is subjected shall be within the safe working stress of the material, the tightening of the wire is carried out in accordance with tables drawn up, either on the basis of tension or on that of dip, for different spans and temperature coefficients. When a table of dips is used, the correct amount of dip is determined by optical means, whilst when a table of permissible tensions is employed the correct tension is decided by means of a dynamometer inserted into the wire under consideration before the span is completed.

Should any slight slacking back occur whilst the wire is being fastened to the insulator, the values given in the table will no longer be complied with, but up to the present no means of directly measuring the tension after erection has existed. It is, however, of considerable importance to be able to determine whether the actual tension in the finished span agrees with the table, especially as it is usual to decide the dip of succeeding lines by comparison with the first one erected.



Arrangement of Dynamometer.

Attempts were at first made to employ a dynamometer of the type in use on cable ships, in which the amount of the force required to bend the cable between two fixed points is used as a measure of the tension in the cable. This method, however, proved unsuitable because small unavoidable kinks in the wire affected the results

* Translation from the *Elektrotechnische Zeitschrift* of a paper read before the Elektrotechnischer Verein, by G. Nicolaus.

very considerably. As the result of further experiment the following method was then devised:—When suspended wires under tension were bent sideways by a definite constant amount, the forces required were found to be proportional to the tensions in the wires. For this purpose the bend must be made sideways and not downwards as the latter introduces additional loading of the wire.

The amount of displacement necessary in order to render the effect of kinks in the wire negligible, was found in the case of ordinary 1·5 mm. diameter bronze wire, to be about 10 mm. in a length of 30 cm.

The instrument employed (see figure) consists of a fixed arm *a* and a round peg *b* free to move in a guide tube. One arm *c* of a bell crank presses against the peg through a ball joint. The bell crank is pivoted on a knife edge and at the end of its other arm a sliding weight *d* is arranged.

When taking a measurement, the instrument is clamped to the insulator. The wire is then placed in position so that the peg *b* and the rounded ends of the arm *a* produce a displacement of 10 mm. The tension in the wire then presses the long arm of the bell crank up against a stop until the sliding weight is drawn out sufficiently to counteract the force. The bell crank then swings freely on its knife-edge support (arranged in the resultant direction of the two forces on the crank) between stops, and, when this occurs, the displacement of the wire at each test is exactly the same and the tension in the wire can be read off directly on the sliding weight scale, which is previously calibrated by experiment to $\frac{1}{8}$th of 1 kg.

The ball and knife-edge arrangement employed reduces the friction to a minimum, and, with a little experience, readings of line tension accurate to $\frac{1}{8}$th kg. are obtainable.

THE FARADAY SOCIETY.

The April meeting of this society was held on Tuesday, the 4th inst., Prof. A. K. Huntington presiding. Mr. A. H. Hiorns opened the proceedings with a Paper on "Alloys of Copper and Bismuth," in continuation of his previous studies of the structure and composition of binary copper alloys, but the remainder of the meeting was again devoted to the electric furnace and its products.

Before he left for Australia, Mr. E. Kilburn Scott, at the January meeting, gave a hurried sketch of his Paper on "Refractory Materials for Furnace Linings," and this having since been printed and circulated, came up for consideration and gave rise to a very useful discussion. The Paper deals only with electric furnace products, and confines itself principally to the silicon carbides—carborundum, amorphous silicon carbide, and siloxicon, and electrically-shrunk magnesite. The carbides are now coming into favour as materials for washing, to a depth of half a millimetre or so, over ordinary furnace linings, and as far as present imperfect experience goes, they appear to give much satisfaction. Carborundum, which, as everybody knows, is crystallised silicon carbide, was first used in this way by Engels as far back 1899, and judging from some specimens exhibited by Mr. Richard Cremer, the carborundum wash can give a very satisfactory account of itself, even after passing through the severest ordeals. One of his samples was a piece of Glenborg firebrick, coated with carborundum taken from a furnace heated with coal-dust firing. The brick had been exposed to a very high temperature, and yet the carborundum surface had protected it exceedingly well. Another specimen was a small injector furnace, of which one-half was washed over with carborundum. The furnace was heated with a blowpipe, and while the uncoated parts had visibly fluxed, the carborundum-covered portions were perfectly intact. For washing over ordinary furnace-kilns the carborundum is ground very fine and mixed with silicate of soda. After thoroughly brushing the freshly set firebrick to get rid of dust, &c. (the mixture does not stick readily to a surface which has been already fired), the carborundum is painted on to the depth of about half a millimetre. It is then left for about twenty-four hours to dry, and afterwards the firing is started up gradually. The result is that a layer of carborundum becomes cemented over the whole surface of the firebrick lining, cracks and all, and if properly done it adheres quite soundly. On the carborundum-coated bricks shown by Mr. Cremer the coating had not been washed on, but had been forced on under pressure to a thickness of about a quarter of an inch, the surface of the bricks having been cut away so that the lining interlocked with the bricks after the fashion of a dovetailed joint. Mr. Cremer pointed out that carborundum must not be used for coating silica bricks on account of the expansion and contraction of the latter. There is some difference of opinion as to the best binding material to use with carborundum, and where basic slags or materials have to be taken into consideration, Mr. Scott recommended the use of fireclay instead of sodium silicate (water glass), but Mr. Cremer, who claimed to have made hundreds of tests with all varieties of binders, stated that the latter was a perfect binder for carborundum, and excelled all others he had seen used. Mr. W. Murray Morrison, on the other hand, favoured the use of tar, especially for high temperatures, where the increase of conductivity caused by it was of no consequence. Carborundum has also been used for lining and coating iron and other metals. Where it is used for this purpose, however, the metal must remain constantly heated, as otherwise the coating will burst off when the metal cools down. In the case of some central iron pipes for a particular blast furnace the useful life was increased from $2\frac{1}{2}$ to 9 months. Nothing but carbon, preferably charcoal, is known at present for use at temperatures above the decomposition point of carborundum, but possibly further study of electric furnace products may produce highly refractory materials.

Siloxicon, SiCO, is a comparatively new material from the industrial point of view, its manufacture having been patented by Acheson as recently as 1903. It is very highly refractory, having a neutral action on both acid and basic slags and being insoluble in molten metals, and it does not decompose before 3,000° C., being then transformed into silicon carbide. Siloxicon is, to a certain extent, a self-binding material, but it is best to add alumina, and in certain cases non-alkaline clay, if desired to make up articles that can be baked before use, and if used for linings, either silicate of soda or coal-tar as binding materials. Mr. Gaster said he had recently been informed by the Acheson Co. that a siloxicon wash must not be used indiscriminately in all cases. For example, in lining Portland cement kilns a mere wash was insufficient; hard bricks of the material were necessary.

Amorphous silicon carbide was found by Acheson to constitute the white or grey-greenish looking shell surrounding the zone of crystallised carbide in his carborundum furnace. Talbot used it as a refractory furnace lining in 1899, but more recent experience has shown that, being a fair conductor of heat, it is best used merely as a wash over ordinary firebricks. The best binding materials to use are glue, provided silica be present or added, sodium silicate where the lining is not exposed to a very high temperature, or gas-tar, which gives articles of considerable mechanical strength. If the latter is for any reason objectionable, the particles of the carbide may be fritted together by heating at a high temperature for several hours in an oxidising atmosphere, a temporary binding agent, such as a solution of glue, being used for that purpose. This treatment, according to Fitzgerald, superficially oxidises the grains of carbide and fuses them together.

The most interesting section of Mr. Scott's paper is that which describes the results of experiments made by him in 1902 in Norway, at the instance of Mr. H. G. Turner, the owner of some Indian deposits, on the electrical shrinking of magnesite. Ordinary calcined magnesite, that is, magnesite with the carbon dioxide driven off, is now recognised, as the best material for lining basic open-hearth furnaces, converters, cement kilns, and other furnaces where dolomite, chromite or silica cannot be used. In America magnesite or, to be more accurate, magnesia, is largely used for steel furnaces, as its durability, freedom from moisture and silica and resistance to conversion from basic slags and metallic oxides, make it cheaper in the long run than other linings, such as dolomite, which are used in England.

Prof. H. N. Dains, in a useful communication to the discussion, sent in some detailed descriptions and analyses of the various magnesite deposits at present available. The principal of these are the Indian, Grecian, Styrian and American, and now some deposits, somewhat silicious however, have recently been found in South Africa. Of these the Indian magnesites are the purest, and, therefore, the most refractory. The Grecian magnesite approaches nearest to the Indian, but the lime in it is harmful, while the Styrian deposits are less refractory still, on account of the large percentage of iron oxide they contain.

The shrinking of magnesite takes place in two stages. First, the carbon dioxide has to be driven off. This is really

calcining, and it is misleading to call it shrinking, as Mr. Scott does; a temperature of 800° C. is all that is necessary to expel the last traces of CO_2, and the calcining increases the specific gravity from 3 to about 3·38. It is doubtful whether an electric furnace is the proper medium in which to carry out this calcining. In the first place, the temperature required is too low for electric heating to be economical, and, secondly, as pointed out by Mr. Hutton, the CO_2 given off would rapidly consume the electrodes. But shrinking proper, that is, fusing the calcined magnesite, and converting it into crystallised magnesia, is a process that can only be satisfactorily and economically carried out in the electric furnace, seeing that a temperature of 3,000° C. is required, and its specific gravity is increased to 3·58, or to 3·65 according to Moissan. In the experiments described by Mr. Scott, the shrinking was carried out in the Siemens and Halske intermittent calcium carbide furnaces at Meraker. The magnesite was simply passed down the chutes in the same way as the raw materials for making the carbide, and when once the arc was fairly started the magnesite could be fed in quite rapidly, and no carbon or other material was necessary. After a two hours' run with 3,500 amperes at 65 volts, a block 15 in. cube of almost pure crystallised magnesia was obtained, so that to make 3 cwt. about 300 H.P. for two hours was required. But it transpired that these figures were by no means exact, because the experiments were carried out on only lightly calcined magnesia that had been lying about, and had taken up CO_2 and water. These experiments have been continued by Mr. Naumann, the engineer in charge of the Meraker carbide works, and it is to be hoped that Mr. Turner, for whom the experiments are being made, will see fit to publish the results of this very interesting work.

From electrically-shrunk magnesia excellent bricks have now been made, and Mr. J. E. Stead has expressed himself satisfied that this material cannot be melted by the highest temperatures used in metallurgical furnaces. It has now been tested as a wash over the fire-brick lining of a carbide of calcium furnace, and it was found that the bricks lasted for 200 hours without repair, whereas the unprotected bricks required repair after a five-hours' heat. There seems to be no doubt that the crystallised material will prove of special value as a refractory material in general metallurgical practice, and as it does not form a carbide with carbon it is particularly suitable for lining electric furnaces. It should be pointed out in this connection that it is a mistake to suppose that the lining of an electric furnace is subject to specially severe temperature conditions. In the first place, the intense temperatures are very local; and secondly, in a properly designed electric furnace, the material under treatment should form the actual furnace lining.

Much work remains to be done in connection with the scientific and systematic study of refractory furnace materials. Mr. Gelstharp, for example, asked for a material which will withstand the action of tri-silicate of soda and lime at high temperatures for use in glass furnaces of the tank type, and there is little reliable and exact information at present available concerning the mechanical properties, the effects of known high temperatures, and in particular the thermal conductivities of the materials now used for the linings of furnaces.

The meeting wound up with a paper by Mr. R. S. Hutton and Mr. W. H. Patterson, entitled "Electrically-Heated Carbon Tube Furnaces." The present communication was only intended to be preliminary—further details and experiments are promised for a future Paper—and it contains a description of two types of experimental electric furnaces designed by the authors, which are sure to be found useful in metallurgical and chemical laboratories, as they are so simple that anybody can set them up for himself. The tube type of furnace is the most readily available for the very highest temperatures, and very satisfactory results can be obtained with a very simple type of construction. The important points to be borne in mind in designing such furnaces are keeping cool the end connections, protection of the tube from contact with air, and heat insulation. The first type is a graphite tube furnace, bored from a solid rod of Acheson graphite. This material can be machined as easily as a metal, and therefore it is only necessary to screw the tube into end plates, also of graphite, and the furnace is practically complete. The central portion is of course thinned down, and it is surrounded with finely-granulated carborundum, held in place by brickwork, which is found to be an excellent jacketing material. In such a tube furnace, 1·5 cm. internal diameter and 28 cm. long, a current of 320 amperes at 9·6 volts will melt nickel in 13 minutes and platinum in 16½ minutes. Where much work has to be done, the time necessary for boring and turning graphite tubes is obviously a disadvantage, and therefore the authors have also designed an agglomerated carbon tube furnace. The tubes are readily obtainable from arc carbon manufacturers. This amorphous carbon cannot be machined as graphite can, so a new device for making the end connections had to be worked out, and this appears to be so satisfactory, and withal so simple, that small electric furnaces are brought within the scope of almost any laboratory where large currents are available. The ends of the carbon tubes are coppered electrolytically and soldered to copper tube extensions provided with water jackets to keep the joint cool. Into these the current is led by copper clamps, and glass tubes for the passage of gases, &c., are connected by means of rubber stoppers. Carborundum kept in place with an external asbestos tube serves as the jacketing material, as before. Tube furnaces up to 67 mm. internal diameter have been successfully made in this way, and it is hoped to use these, and even larger tubes, in a vertical position, so that large crucibles may thereby be heated. In such a tube 850 amperes at 13 volts melt nickel in 12 minutes and platinum in 20½ minutes. In a special tube-furnace for experiments in an atmosphere of pure gas, the furnace proper is surrounded by an outer jacketed carbon tube, also provided with water-cooled copper extensions, and the joint between the two is gas-tight, hydrogen being passed through the space between the tubes. For most experimental work, however, the simpler mode of construction is all that is required. In laboratories where very much current is not available the furnaces may be made to take quite small currents at correspondingly higher voltages by the ingenious method, patented by Ruhstrat & Grimmer, of cutting a spiral on the tube, and thus increasing its resistance.

One of the great advantages of these tube furnaces is the ease with which regulation of temperature can be effected, either by varying the current, or else by slightly shifting the position of the boat or crucible under treatment. The authors rightly point out that there is a vast amount of physical and chemical high temperature work which can only be carried out when the heating is under perfect control, and we heartily agree with them in thinking that there are numerous applications for which these carbon tube furnaces are essentially fitted.

THE LEGAL RELATIONS OF SUPPLY COMPANY AND CONSUMER.

THE legal questions and answers which are published from time to time in these columns, serve to show that intricate questions sometimes arise between company and consumer. The paucity of legal decisions dealing with the relationship of supply company and consumer, indicates that recourse is not often had to litigation. While this is a matter upon which the parties to the disputes are to be congratulated, there is no doubt that a few "leading cases" upon the questions which are most canvassed would be of great advantage to the electrical world.

It will have been noticed in this connection, that in answering the various questions addressed to him, our legal contributor is but seldom able to quote a case in support of the view which he expresses.

The problems with which we deal from time to time are not by any means confined to disputes between company and consumer. As we shall hope to show in the course of the present article various questions arise from time to time in relation to the powers and duties of those who undertake the private supply of electricity.

The question whether a local authority who are supplying electricity can enter into "free wiring" agreements if their provisional order does not authorise them to do so has also arisen during the past year. It seems to have been made quite clear by the case of the Attorney-General *v.* the Mayor, &c., of Barnstaple (reported in the Electrical Review, May 8th, 1903, p. 771), that statutory power must be obtained for this purpose. A precedent for the necessary clause will be found in the Gateshead Electric Lighting Provisional Order, 1899. It is conceived, however, that the following clause, which appeared in the Halifax Corporation Act, 1898 (61 and 62 Vict., ch. cxlvi.) (Sec. 35), would suffice. There the Corporation were authorised "To purchase, hire, sell, let on hire or otherwise deal with dynamos, electric motors, accumulators, meters, burners, arc and other lamps, fittings, wires, plant, engines, conductors, machinery, apparatus and appliances for, or in relation to, the production, supply, distribution or utilisation of electricity, or required or used for or in connection with their electrical works and undertaking."

In the case of companies, so long as the memorandum of association allows them to make contracts for free wiring, it would seem that they may do so irrespective of the terms of their provisional order.

We have also been asked to consider how far it is competent for a local authority supplying electricity, to transfer their powers under an existing provisional order to a company. It was formerly the practice of the Board of Trade to insert in provisional orders in favour of local authorities a clause authorising a transfer, with the consent of the Board, of the powers, duties and liabilities from the local authority to a company or person. The policy of the Board has now undergone a change, and no such clause is inserted except for good cause shown. In several cases, however, transfers have been authorised by special provisional order. See, for instance, the Saddleworth and Springhead orders, respectively confirmed by the 2 Edw. VII., ch. l. xviii.

Various tactics are adopted by electric supply companies and local authorities who supply electricity for the purpose of making consumers take supply at a pressure different from that at which the company originally undertook to furnish energy. In one case which was brought to our notice, a corporation commenced to give a supply to their consumers at 100 volts. Later on they changed their supply to 200 volts, and sought to make all their consumers accept current at this pressure. One consumer had an 80-lamp installation adapted for pressure at 100 volts; but he took on some new lamps at 200 volts. Later, the company reduced their charges for 200-volt current to a flat rate of 4½d. per Board of Trade unit; but they continued to charge the consumer in question at the rate of 6d. per unit (with a rebate of 4½d.) for his 200-volt supply, and refused to put him on a level with the other consumers unless he undertook to make, at his own expense, all the alterations necessary for a 200-volt supply throughout. As it seems to us, a supply company has no right to attempt to bring pressure to bear upon a consumer in this way. It is one of the principles of the Electric Lighting Acts that a consumer in any district is entitled to a supply on the same terms on which any other company or person in the area is entitled to a corresponding supply. Any violation of this duty may render a supply company liable in penalties.

The question has frequently arisen during the past year as to whether a company or person can supply electricity without the authority of a provisional order or special Act. If a man finds that his neighbour has an electrical installation, he may find it cheap and convenient to obtain a supply from this source upon terms which can be arranged. Is there anything to prevent such an arrangement being concluded? The answer to this question is that there is nothing in the electric lighting Acts to prevent the private supply of electricity, and provided it is not necessary to place electric mains under or over any highway, it is competent for any man to supply his neighbours with electrical energy. Where, however, it becomes necessary to make use of overhead conductors, the Board of Trade regulations with regard to overhead wires should be consulted (a *précis* of these regulations will be found in the Electrical Review, September 9th, 1904, p. 439). It is to be observed that these observations apply, even though there is a company or a local authority granting a supply under a provisional order in the district.

A concrete instance is furnished by another question which was put to us. It was as follows:—"A company owning ironworks are desirous of providing electric power to about five of their collieries, which are situated at distances varying from one to five miles from their works. It is proposed to lay down H.T. plant—say, 2,000—6,000 volts—at these works, and to convey the current by bare overhead wires to the various collieries, the total amount of power required being on the average 1,000 H.P. These wires would in a few cases have to cross public roads and footpaths, but for the greater part of the way they could be erected in fields occupied by the tenants of the company." The question was whether an installation could be let up on the lines suggested. Provided (*a*) the consent of the highway authority is obtained to the stretching of cables across public roads; and (*b*) the consent of the Board of Trade is obtained to the use of the overhead wires (which would have to be insulated where they crossed a street or road), an installation of this kind could be put up by the company.

It is well known that a supply company is under obligation to observe strict equality in its treatment of consumers. The justice of this rule is apparent when it is remembered that the undertakers have, to a certain extent, a monopoly in their district. The rule that there shall be equality, however, does not mean that the price per unit must be the same to every consumer. For instance, if it could be shown that the supply to a particular consumer was large and very constant, or that he made use of the supply for lighting purposes in the daytime (as the manager of a theatre might do), the undertakers would not be guilty of undue preference in granting him special terms.

The fact that electricity is often supplied by companies and local authorities upon special terms for motors, or, at what are termed "motor rates," has occasionally induced the question whether a consumer would be entitled to demand a supply for a motor-generator at motor rates. By doing so he might be able to obtain a supply of electricity for lighting purposes at a lower rate than if he took it direct from the mains. We have no doubt that a supply company would be entitled to refuse a supply at motor rates under these circumstances. The reason why a supply company can afford to make special terms for motors, is that a motor used in the ordinary way for driving machinery would in all probability be run at a time when the engines at the station were relieved of their lighting load. It is obvious, therefore, that the use of a motor-generator for lighting purposes might result in loss to the supply company.

The insulation tests demanded by supply companies appear to vary considerably in different districts, so much so that the question occasionally arises as to how far the tests required are unreasonable. A correspondent who wrote to us in July, 1904, referred to two extreme cases. In the first of these the rule was that "The insulation resistance to earth shall not be less than 10 megohms divided by the current." In the second case, the rule was that "The resistance in megohms shall be not less than the number obtained by dividing the pressure of supply by the number of lamps." Assuming that the prescribed test can be shown to be unreasonable, has the prospective consumer any remedy? It seems that the Board of Trade rules prescribe no standard test of insulation; they merely impose upon the supply company the duty of taking necessary precautions against short circuit, and apparently the company are at liberty to decide what tests are necessary. At the same time we anticipate that if the tests prescribed were beyond the bounds of reason, the consumer might be in a position to bring the company to book for refusing to give that supply. The *onus* of showing that the insulation tests were reasonable would then be upon the company.

The vagaries of meters sometimes give rise to questions as between company and consumer. Is the "decision" of the meter dial absolutely final upon the question as to how much energy has been consumed? It is obvious that this is a matter of importance from both points of view. In the case of a gas meter, the meter register is only *primâ facie* evidence of the amount of gas which has passed through the instrument; but it is provided by the Electric Lighting (Clauses) Act, 1899, that if any difference arises between any con-

sumer and the undertakers as to whether any meter, whereby the value of the supply is ascertained (whether belonging to the consumer or the undertakers), is or is not in proper order for correctly registering that value, or as to whether that value has been correctly registered in any case by any meter, that difference shall be determined upon the application of either party by an electric inspector, or *where the local authority are the consumers, by an inspector to be appointed by the Board of Trade*,* and that inspector shall also order by which of the parties the costs of and incidental to the proceedings before him shall be paid, and the decision of the inspector shall be final and binding on all parties. Subject as aforesaid, the register of the meter shall be *conclusive evidence*, in the absence of fraud, of the value of the supply.

Although this clause apparently makes the decision of an inspector final, cases are on record in which consumers have been relieved from having to pay the amount registered by a meter. Of course, if the meter were proved to be incorrect, a supply company would probably refund any money which had been overpaid. If they did not do so, it would, in our view, be open to the consumer to bring suit for the amount overpaid.

MERSEY RAILWAY: RESULTS OF ELECTRIC WORKING.

In the last issue of our contemporary, *Transport and Railroad Gazette*—which, by the way, is the most interesting of all English railway publications that come before us—there is a useful article, showing by means of several tables the substantial progress that has been made with the Mersey Railway system since conversion from steam to electric working. The report of the directors for the last half-year and the remarks made by the chairman of the company have already appeared in the Electrical Review (see our issues of March 24th and 31st), so we merely reproduce the table matter from our contemporary's article. The results of working for the half-year ended December, 1904, are compared with those of the corresponding half-year of 1903, as follows :—

Table I.

	Dec. half, 1904.	Dec. half, 1903.	Increase or decrease.	
Gross earnings	£41,788	£37,358	+£4,430	+ 11·9 %
Expenses	32,883	32,441	+ 442	+ 1·3 „
Ratio	(78·69)	(86·83)	− (8·14)	—
Net earnings	£8,905	£4,917	+ £3,988	+ 81·4 „
Net income	8,948	4,904	+ 4,044	+ 82·5 „
Debenture interest, &c. ...	17,348	17,353	− 5	—
Amount payable by the British Westinghouse Co.	8,400	12,660	− 4,260	—
Balance	—	£211	− £211	—
	Miles.	Miles.	Miles.	
Train-mileage	415,625	401,046	+ 14,579	+ 3·6 „

The chief items of expenditure are compared thus :—

Table II.

	Dec. half, 1904.	Dec. half, 1903.	Increase or decrease.	
Way and works	£3,630	£2,802	+ £828	+ 29·6 %
Locomotive power (total)	9,101	8,702	+ 399	+ 4·5 „
Locomotive running ...	6,588	6,575	+ 13	+ 0·2 „
Loco. repairs and renewals	2,513	2,127	+ 386	+ 18·4 „
Carriages	1,292	1,394	− 102	− 7·3 „
Traffic expenses	11,530	12,274	− 744	− 6·0 „
General charges	2,858	2,714	+ 144	+ 5·3 „
Capital expenditure ...	2,147	1,137	+ 1,010	—

The development of traffic since electrification is shown in Table III.

Table III.—Passengers.

	June half.	Dec. half.	Year.
1904	4,499,147	4,657,876	9,157,023
1903	3,201,644	4,153,777	7,355,421
1902	3,104,294	2,844,708	5,949,002
Increase (2 years)	+1,394,853	+1,813,168	+3,208,021
	=45 %	=64 %	=54 %

Season tickets which are not included in this table show an increase of 36½ per cent. during this period.

* The words in italics are omitted from orders in favour of local authorities out of London.

In Table IV. there are stated the train-mileage, passenger earnings and receipts per train-mile in the past three years :—

Table IV.

	Train-mileage.	Passenger receipts.	Receipts per train-mile.
1904	827,308	£79,744	£23·13
1903	619,354	66,895	25 92
1902	309,100	58,564	45·45
Inc. or dec. (2 years)	+518,208	+£21,180	−£22·30

Table V. is a general comparison for the three years of the gross receipts, working expenses, and net earnings :—

Table V.

	Gross earnings.	Expenses.	Ratio.	Net earnings.
1904	£82,707	£66,475	80·38 %	£16,232
1903	69,636	64,503	92·68 „	5·133
1902	61,251	57,536	94·01 „	3,715
Inc. (2 years)	+£21,456	+£8,939	−13·63 %	+£12,517
Per cent. ...	35 %	15·5 %	—	338 %

PATENT SIPHON AND PRESSURE GAUGE.

A novel pattern of pressure gauge, styled the "Vulcan," has been brought out by Messrs. J. Hopkinson & Co., Ltd., of Huddersfield, and is illustrated herewith. The switchboard bracket voltmeter has evidently influenced the design, for the dial is of the sector

Fig. 1.—"Vulcan" Gauge, with Siphon Disconnected, and Pump Attached for Testing.

type, with figures marked on white opal, and illuminated from behind by an incandescent lamp, while the gauge is rigidly supported by a swivel arm, and can be swung to one side so that all the gauges on a battery of boilers are visible from one position.

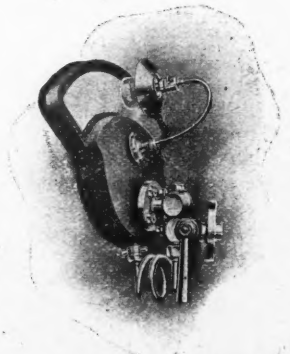


Fig. 2.—Rear View of Gauge in Normal Condition.

The dial is finely graduated only up to the working pressure, the higher graduations being widely spaced, and used for testing purposes only. A special feature is the swivel siphon, which can be swung aside and blown through without disturbing the gauge ; and the gauge itself can be readily tested in position, by means of a "Vulcan" pump and tester, as shown in fig. 1. The gauge is thermally insulated from the siphon by a washer of non-conducting material, to keep it cool. The apparatus appears to be a decided step in advance.